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A History of Satellite Reconnaissance
Volume IIA

PREPARED FOR
THE NATIONAL RECONNAISSANCE OFFICE

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A HISTORY OF SATELLITE RECONNAISSANCE

VOLUME IIA - SAMOS

by

Robert Perry

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PREFACE TO VOLUME IIA

This volume of A History of Satellite Reconnaissance includes two parts, separated mostly because of bulk. It covers the origins, progress, and eventual demise of the satellite reconnaissance system generally known as Samos over a period extending from initial program acceleration in 1957 (following nearly 10 years of studies and very modest technical development activity, the whole costing rather less than $10 million) to the cancellation of the last photographic system in the Samos series in October 1963. Actually, work on the last of the "real" Samos systems was terminated in July of that year, but a half-breed survivor, Lanyard, lingered on for another three months.

Samos and its close relatives were distinguished from other photographic reconnaissance satellites in several respects. Notably, the six numbered systems in the E-1 through E-6 series were under high but ordinary security controls. Lanyard was an exception, and Spartan might have become a second had it survived; but Lanyard represented an attempt to transfer the better parts of one Samos system, the E-5, to the technical and operational environment of the highly successful Corona. It was attractive mostly in the absence of any alternative system with resolution better than that of Corona -- about 17 feet at the time. Once a better system emerged (and even

Corona shortly managed to surpass Lanyard performance, [redacted] made it totally inconsequential), Lanyard was an anachronism. As for the others, that they were given no special security protection said something of their reconnaissance programs.

The Samos family of photo reconnaissance satellites included three with readout antecedents (E-1, E-2, and E-3), four with film recovery capability (E-4, E-5, E-6, and Lanyard, a stereo-configured E-5 camera redesigned to fit a Corona payload and recovery package), and the spin-stabilized P-35 weather reconnaissance system. P-35 probably should not be counted as a Samos program because it was strikingly different in both technology and management. And the P-35 program had another distinction: success. It is included here partly for convenience, but mostly because it did not fit elsewhere.

The Samos program cannot be addressed in perspective without including consideration of [redacted] but conducted in quite another environment--and with very different results. The background and antecedents of [redacted] therefore, discussed in terms of their relationship to the original Samos effort as that becomes appropriate. However, [redacted] the [redacted] major photo reconnaissance satellite programs to emerge successfully from the 1960s, are separately the subjects of Volume III in this series.

Matters of variant nomenclature were of sufficient concern for Volume I to warrant a prefatory discussion in that volume. They do not represent comparably troublesome items here. Samos titles and designators changed from time to time, often enough to insure the confusion of later researchers, but such changes are treated as they occur. References to program segments have been made consistent by adhering to the original E-series designators throughout.

CONTENTS, VOLUME IIA

Preface ii

IV SAMOS: FROM SPUTNIK TO POWERS (1957-1960) ... 1

Notes on Sources 47

V SAMOS: REALIGNMENT CONTROVERSY (1960) 52

Notes on Sources 91

VI NEW DIRECTIONS IN SATELLITE RECONNAISSANCE (August 1960-May 1961) 96

Notes on Sources 147

VII PHOTO-READOUT 1960-1963 (E-1, E-2, Subsystem I, and Tape) 151

Notes on Sources 197

VIII THE P-35 WEATHER SATELLITE PROGRAM 203

Notes on Sources 297

IX THE E-4 MAPPING SATELLITE (PROGRAM 1A) 305

Notes on Sources 316

Illustrations have been separately bound in an Appendix volume.

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IV SAMOS: FROM SPUTNIK TO POWERS (1957-1960)

Note: The pre-1958 background of the Samos program has been treated in considerable detail in Chapter I, Volume I, of this series. It is only casually relevant to later events in the basic Samos program, which was influenced more by Sputnik and by the rapid pace of photo-satellite technology than by plans laid in the 1954-1957 period. Directly causitive factors are noted in the first pages of this chapter; for additional detail the reader should refer to Volume I and to other and more extensive narratives there cited.

Characteristically, the United States reacted to Sputnik and the threat it appeared to represent by dumping money and manpower into a hodgepodge of space and satellite programs. For practical purposes, the initial reaction was channeled into three general areas. First and foremost, there began a frantic effort to "restore the national image" by some sort of flamboyant feat that would demonstrate the excellence of American technology and prove the essential soundness of pre-1958 space program management. Predictably, the effort was a flat failure. The early beneficiary was Vanguard, the American "scientific satellite." Vanguard launches, starting in December 1957, probably represented the most widely publicized set of failures in modern history. Although some Vanguards eventually went into orbit--and the program consumed vastly greater sums than ever contemplated--the effort chiefly served to prove that the "space program" of 1955-1958 had been distinguished by strikingly bad judgment at the secretarial level. The Army's Explorer satellite, rescued from ignominious storage in a warehouse where it had been hidden for months, finally junketed into orbit four months after Sputnik I. It was the petulant contention of Major General J. B. Medaris, chief of the Army's rocket research program, that the feat could have been performed many months earlier had it not been for the intransigent obstructionism of the Secretary of Defense. For the remainder of 1958, a succession of discounted failures and over-publicized successes in space probe and satellite projects chased across the front pages of the nation's newspapers.

A second response to the Sputnik scare was the creation of new agencies, czars, committees, and study groups--each supposed to perform some magic that would suddenly compensate for five years of misjudgment and maladministration. Most were of transitory importance. Only two endured: the Advanced Research Projects Agency, named custodian of all military-purpose space activities, and the National Aeronautics and Space Administration, charged with conducting a peaceful-purposes scientific space program.

The third pattern of response to Sputnik was the acceleration, expansion, and modification of established space developments. With minor exceptions, these were based on the WS 117L reconnaissance satellite program, a starveling which until late 1957 had been carefully hidden from public view because it could not be easily accommodated to the "peaceful uses of space" image prized by the Eisenhower administration.

Conducted by a scant handful of imaginative scientists and engineers, WS 117L had been allotted sparse resources since its 1954 inception. Stunted though it was, it nonetheless represented the only well-grounded United States space program when space suddenly became respectable, in October 1957. As might have been anticipated, pressure for acceleration and for the creation of interim satellites focused on the project office immediately thereafter. Roles and assignments for the booster and second stage proliferated. A serendipitous compatibility of the WS 117L upper stage with the Thor missile permitted creation of a deviant program, later named Discoverer, which had some prospect of early success. But Discoverer was actually a cover program cloaking the quiet development of the Corona reconnaissance payload. For practical purposes, Discoverer-Corona went its own way, independent of the main course of WS 117L development and ignored by most WS 117L participants. They concerned themselves with the continuing effort to provide photographic reconnaissance from a system embodying the Atlas booster and the Lockheed second stage that ultimately became Agena.

Thor and Atlas became first-stage boosters for a variety of probe and satellite payloads, and the upper stage of the original WS 117L (Agena) was called upon to support several newly conceived satellite programs, both military and scientific in objective.

What remained in the 117L effort after the propaganda projects had been peeled away, after scientific satellites and communication satellites and navigation satellites and weather satellites had been shaped and separated, was a military reconnaissance satellite program that had rather surprisingly survived the first year after Sputnik.

Through most of 1958 the concept of 117L satellite reconnaissance involved an Atlas that would boost into orbit a camera-carrying Agena. Rather than detaching a reentry capsule to return exposed film (as did Corona), the orbiting Agena would rely on a scanner-transmitter to transform photographs into electronic signals and relay them to ground stations for reconstruction. Two alternative techniques involving infrared-sensitive detectors (subsequently the Midas program) and electronic signal recorders (later the individual ferret subsystems) still were embryonic at that time.*

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*Midas, which was completely separated from the balance of the WS 117L effort during 1959, is not considered part of that effort for the purpose of this account. Electronic sensor subsystems and their development are treated separately.

Originally, WS 117L had been conceived around a television transmission system and magnetic tape as the mode of returning reconnaissance information from orbit. By 1956, however, the television-magnetic tape technique had been relegated to secondary consideration and primary emphasis shifted to a conventional film-camera combination with on-board film processing and electronic transmission.[1] The future use of either magnetic or electrostatic tape was not excluded from consideration, but for the moment technological difficulties made them less than feasible.

As late as March 1958, WS 117L embodied concepts refined in 1956. A "pioneer" system built around a six-inch (focal length) lens, and an "advanced visual" system embodying a 36-inch lens were conceived as the basic data gathering devices. Both infrared and electronic collectors were being considered by that time, but the chief emphasis remained with visual modes.[2]

Although "readout" remained the accepted data retrieval method, suggestions that physical recovery of a film capsule would be a preferable alternative had been heard at intervals since mid-1956. In June of that year, Rand researchers published an unassuming classified paper which suggested the feasibility of recovering satellite payloads, briefly noted reasons for considering that option, and defined the technical requirements of a recovery system. Two of the "justifications" were basic to the Corona program, adopted early in 1958: photographic coverage of closed areas in advance of the availability of a readout system, and the accumulation of knowledge concerning recovery techniques. A third justification was implicit in the subsequent conflict between recovery and readout: the amount of information a satellite could gather and return in a given period was considerably larger by way of capsule recovery methods than by readout. The study affirmed the technical feasibility of recovery, categorized it as an "inherently simple method," and included calculations indicating that a 50-pound payload could be returned in a capsule weighing only 228 pounds.[3]

Slight consideration was given the suggestion over the following year, partly because of funding difficulties that hobbled the entire reconnaissance satellite effort during that time but more immediately because there still was no proof that an encapsulated payload could be retrieved from orbit. Not until 1957, when the first ballistic missile nose cones were recovered, did scientists have empirical proof that any object re-entering the atmosphere from orbital altitudes could survive. Under the circumstances, it seemed sounder to hinge a reconnaissance satellite program on known and demonstrated image transmission techniques than on the considerable uncertainties of atmospheric re-entry. Moreover, satellite reconnaissance requirements as then understood tended to emphasize the need for attack warning rather than for targeting, search, or surveillance. The objective of obtaining prompt intelligence on specific activities of a prospective enemy made readout, with a quickly available product, seem much more attractive than recovery, with its indeterminate delay for retrieval and processing of film that might have been exposed days earlier.[4]

Interest in recovery revived in October and November 1957, partly because of a new Rand study which urged the substitution of a deboost and water recovery mode for the readout technique embodied in the current 117L program. Although paying particular attention to the feasibility of early systems based on Thor boosters, Rand also suggested development of a family of satellites that included vehicles lofted by Atlas boosters.[5]

Such proposals were generally submerged in the enthusiasm for the Discoverer-Corona programs that evolved during the early months of 1958. Nevertheless, as early as March 1958 the prospect of employing recovery techniques in the Atlas-boosted WS 117L began to receive renewed consideration. Indeed, one of the secondary justifications openly volunteered for the Discoverer at the time of its inception was that it might prove the value of recovery "as a data acquisition method."[6] Brief suggestions that such an option deserved investigation appeared in development plans that the Ballistic Missiles Division submitted to Air Force headquarters on 15 March and on 1 July 1958.[7]

If it had not other importance, the mention of recovery as an alternative to the accepted readout mode hinted that some question of readout adequacy had been raised. On the surface, there was as yet no indication that the question might become a controversy.

The "pioneer" readout system, later the E-1,* was intended to provide in-camera definition approaching 100 lines per millimeter, based on an f/2.8 lens in combination with a very fine-grain film. Orbital operation was predicated on the assumption that the camera system would function for five minutes during each pass over the "area of interest" and that on subsequent orbits three receiving stations within the continental United States would "read out" the intelligence thus acquired. (The stations were to be located at Fort Stevens, Oregon,

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* The letter designators assigned individual WS 117L subsystems had the following basis: Subsystem A - Airframe; B - Propulsion; C - Auxiliary Power; D - Guidance and Control; E - Visual Reconnaissance; F - Electromagnetic Reconnaissance (Ferret); G - Infrared Reconnaissance (later Midas); H - Communications; I - Data Processing; J - Geophysical Environment; K - Personnel; L - Biomedical Recovery. The E-designators ultimately ran from E-1 through E-6, the F-designators through F-4.

Ottumwa, Iowa, and New Boston, New Hampshire; Offutt Air Force Base was to be the satellite operations control center.) It seemed probable that an efficient processing and dissemination complex would permit at least 10 percent of the derived intelligence to reach the central analysis station within one hour of its receipt and the remainder within eight hours. The Strategic Air Command wanted an eventual "near real time" system, of course, hoping to use it for attack warning as well as general intelligence. Each of several vehicles to be aloft simultaneously was to have a useful time on orbit of 10 to 30 days, limited principally by battery life. The initial system (E-1) was designed to permit identification of ground objects measuring 100 feet on a side. The "advanced" E-2 was to produce images that would permit "visual resolution" of objects 20 feet on a side and was to have a potentially long orbital operating life--assuming the availability of either solar or nuclear power sources.

One key to a useful readout system was a data processing subsystem which would include the equipment, techniques, and procedures to transform recorded raw data into intelligence--and to disseminate it to using agencies. Ground receiving stations, therefore, would identify, record and retransmit information to an "Advanced Reconnaissance System Intelligence Center" (predictably dubbed "ARSIC"). The

Intelligence Data Processing Subsystem ("IDPS"--later Subsystem I) was to be capable of performing all functions needed to transform the raw data into useful intelligence: processing, screening, interpretation, collation, evaluation, indexing, storage and retrieval, analysis, display, dissemination, and presentation.[8]

The orbital vehicle--the upper stage and payload sections--was to be 19 feet long and 5 feet in diameter, was to carry a 2680-pound payload, and including 5080 pounds of propellants would weigh 9300 pounds at launch. The somewhat loosely defined operational concept of March 1958 anticipated that ultimately each of several E-2 satellites simultaneously on orbit would have a useful life of one year and be capable of providing 17-foot ground resolution.[9]

Spot surveillance of selected targets rather than general reconnaissance was the objective of the development program. Surveillance of this nature was intended to provide advance warning of an imminent attack, a concept emphasized by application of the name Sentry to WS 117L in June 1958. Unhappily, concept had little relevance to reality. Although a camera and readout system that could actually resolve objects 17 feet on each side would be capable of locating and identifying intercontinental missile sites, the total system was incapable of such precision. Moreover, within the existing state of the art, the capacity of the system to scan and transmit images to ground stations was severely limited.

Even though electronic transmission of photographs to ground receivers degraded definition, the chief objection to readout was that relatively little area coverage could be provided each day. Exposing the film, transporting it, and processing it presented few difficulties compared to the enormously complex and time-consuming tasks of electronically scanning each negative frame, transforming its photographic content into analog signals, transmitting those signals to ground stations, and reforming the images in those stations.

The readout technique that had evolved by 1958, and which was refined but not radically changed during the next two years, embraced a strip camera subsystem loaded with 4500 feet of 70-millimeter film. (Corona would carry about 15000 feet of three-inch film in its payload.) The film moved past a slit aperture, which served as a shutter, at a rate determined by image motion compensation settings. (The "slit" was actually a line scribed through the aluminum coating on a glass plate.)

Once exposed, the film was pressed against a chemically impregnated web at intervals over a period of approximately 16 minutes. The pre-soaked web contained all the necessary developing and fixing ingredients. After completing the processing stage, the developed film went to a storage section--a series of loops which held it in readiness for later scanning and transmission.

The readout mechanism consisted of a revolving drum line scan tube, a scanner lens system, a light collecter lens system, a photo multiplier tube and a video amplifier. An electron beam which focused on the phosphor-coated inner surface of the revolving drum was emitted through an optically flat window, the light beam going through a scanning lens that was moved vertically by a motor-driven cam. The lens moved a spot of light across the width of the processed film as the film moved laterally through a readout gate. The beam motion had the shape of a square wave, permitting continuous top-to-bottom, bottom-to-top travel rather than returning to a zero point for each scan operation. That portion of the beam which passed through the film was collected by another lens system capable of relaying 75 percent of the transmitted light to a photomultiplier tube which transformed the light energy into electronic signals. After passage through a video amplifier, those signals were relayed to the satellite's communication equipment section for transmission to ground stations.

Image motion compensation, exposure control, and focus factors were set by command from a ground station. Attitude recording, a key factor for interpretation, was provided through inscription of a binary code on the edges of the film.

The process, though complicated, could be performed by existing or available techniques and equipments. Limiting technical factors were the speed and width of the scanning beam, governed by bandwidth (megacycles per second) considerations. Unless reliable traveling wave tubes could be incorporated in the system--and nothing suitable was available either in 1958 or three years later--the usable bandwidth was but six megacycles per second. Even though the E-1 and E-2 systems were designed to limit their coding to white, black and one gray scale, the scanning beam could travel across the width of film only once each second. The beam spanned only one-tenth of an inch of film during each transit. A complete scanner-beam pass--bottom-to-top-to-bottom--required two seconds. The transmission, readout, and reconstruction process transformed the signals from each such path into an 18-inch strip of 35-millimeter film in the ground station. Seven such strips, halved and realigned to conform to the pattern of the original film, could be reassembled into a single print measuring nine inches along each edge.

The basic time limitation was imposed by a requirement that the scanning beam travel slowly enough to read and translate the analog trace contained on the film. The analog information was transformed into electronic impulses which conformed to the black, white, and gray elements contained in that small portion of the film then being read. Provision for better film definition (more lines per millimeter) or a greater variety of tonal indicators (multiple-scale readout representing three, four, or as many as 15 gray-scale varieties and hence providing a wider range of contrasts on the processed "take") required slower scan or a wider bandwidth. The first was unacceptable and the second unobtainable.

Long before flight trials could be attempted, the limitations of the readout technique were well appreciated. Appreciation of the scan-readout time limitations was not difficult. From an altitude of 200 nautical miles, adequate for 30-90 day orbits, resolution of 14-foot objects would involve a scale factor of 1:400,000, so that the 70-millimeter film in the satellite would provide an image covering 270 square nautical miles on the ground for each frame of film. Assuming six-megacycle-second bandwidths and a square curve path for the scan beam, readout time requirements could be expressed as a simple equation. To read out A square inches at R lines per millimeter using a one-gray-tone scale, the time requirement was expressed as: $\frac{2580\, R^2 A}{\text{bandwidth}} = \frac{(2580)\cdot(100)^2\cdot 9}{6.10^6} = 38$ seconds. At one exposure per second for five minutes, readout time for the product of each pass would be 11,400 seconds: three hours! (The figure 2580 was derived from a computation of the number of sample points or bits to be read out in each square inch of film given the assumed definition and gray scale standards.) On the optimistic assumption that a ground station could receive fully useful information for eight minutes during each of five daily passes of the satellite within its reception range, it was apparent that each station could accept no more than 62 individual frames representing 16,740 square miles of target area each day.[10] (An early Corona system could scan 1.5 million square miles each day.)

Such considerations unquestionably influenced the transformation of basic requirements in the period between March and September 1958. By that latter date, Air Force headquarters had clearly indicated its desire that "consideration . . . be given to the use of a recoverable satellite in order to achieve maximum accuracy, information content, reliability of receipt of collected data, and reuse where economically feasible."[11] Nevertheless, the stated objectives of the program were focused on early warning of attack, the collection of general intelligence, and support of the nation's emergency war plan. Use of satellite reconnaissance to assist in determining the war potential of the Soviet Union remained a secondary goal. Readout, even with its acknowledged limitations, still seemed the best means of satisfying the requirements. Indeed, it was quite logical to conclude that a technique of readout which overcame image definition and transmission time objections would more satisfactorily satisfy program objectives than any recovery technique.

Administration of Sentry through the closing months of 1958 was complicated by the fact that the Advanced Research Projects Agency had custody of program funds and exercised a directive authority over the technical content of the effort. Convinced that an alternative to the available readout techniques deserved careful consideration, the Air Force cautiously moved toward a program reorientation that would permit investigation of recovery techniques. But the realignment was complicated by an infusion of ARPA philosophy. Although ARPA Director R. W. Johnson in mid-December 1958 approved a new three-phase approach that included film recovery as well as ferret and readout payloads, the research agency continued to press for the inclusion of an electrostatic tape readout system (later the E-3). Indeed, ARPA came to advocate cancellation of all other visual programs in favor of reliance on electrostatic tape methods.[12]

Although BMD had reservations about the adequacy of the readout systems under development, the division was strenuously opposed to discarding all previous work in favor of a technique which still had not been laboratory-proven. Sentry project officers pointed out that an electrostatic tape payload could not possibly become available for use before November 1961, that at best it would provide the equivalent of 20 lines per millimeter resolution as against the nominal 100 lines per millimeter of the film system, that adoption of the electrostatic tape device would require complete vehicle redesign, and that the specific proposal supported by ARPA (the CBS "Reconotron Proposal") seemed liable to require more nearly 10 years of development than the two or three being promised.[13]

BMD's sharp objections to the electrostatic tape scheme advanced by ARPA found support within the air secretariat. Assistant Secretary (Research and Development) R. E. Horner carried the issue to higher departmental echelons, insisting that even though the proposal seemed theoretically feasible it would be dangerously premature to schedule development of such a technique, much less to make the success of Sentry program totally dependent on it. Horner pointed out to Air Force Undersecretary M. A. MacIntyre that the ARPA-endorsed proposal would not satisfy established requirements, and he urged renewed attention to the development of a recoverable capsule for Sentry, one adaptable to a variety of payloads.

Although the combined weight of objections beat down the more radical aspects of Johnson's recommendations for realigning Sentry, ARPA did not surrender. In a 17 December 1958 memorandum which served as the basis for program redirection, Johnson clearly indicated that ARPA considered the proposed recoverable capsule to be no more than a test-bed development for possible application to both ferret and surveillance systems. It also appeared that Johnson and his advisors had either misunderstood the objectives of Sentry or were misinterpreting the Horner viewpoint. Johnson's incorrect assumption that point surveillance was a relatively new requirement probably was based on an erroneous interpretation of September 1958 requirements documents. In any event, it tended to cloud both the issue and the objectives of program realignment.

The entire question of program management from ARPA offices in the Pentagon had become an irritant during the late months of 1958. Not only had ARPA begun to "adjust" funding allocations, production schedules, and technical objectives at frequent intervals, but the agency had unilaterally overruled Air Force desires concerning placement of missile assembly buildings on Air Force bases, had cancelled Air Force plans for early construction of readout stations, and had attempted to create a high-level review committee to overhaul requirements for the system. Although some of the rulings proved more acceptable, and seemed wiser, in retrospect, it was the implication of the activity that became of most concern to Sentry program managers.

Because of the confusion that surrounded space matters through much of 1958, because of the uncertain authority of the many surviving boards and panels, and because of the apparent administration desire to keep program control concentrated in the Pentagon, it had become most difficult to secure timely rulings and program decisions. More pertinent, many of those decision, when they did appear, seemed completely at variance with the stated objectives of the Sentry program.[14]

The program reorientation of December had a direct influence on the immediate future of Sentry. One of Johnson's chief measures was to reduce effort on the E-1 "pioneer" system, based on a 6-inch focal length camera, and emphasize the E-2, embodying a 36-inch camera. That "guidance" was faithfully reflected in the revised development plan published at BMD on 30 January 1959. Perhaps more important however, the new development plan significantly expanded the earlier stated requirement for a recoverable reconnaissance satellite, calling for development of recoverable capsules concurrent with the last half of the readout program flight test.

The January proposal described a recovery capsule of 60 inches diameter, weighing 1200 pounds, and built around a 600-pound payload. A heat shield which might be either ablative or a sublimation type was intended to separate from the payload package at an altitude of 55,000 feet--

after deceleration from orbital velocities during passage through the upper atmosphere. Air recovery over the ocean in the fashion of the Discoverer capsule was the preferred mode of retrieval. The stated objective of the effort was to demonstrate a technique for recovering photographic payloads. Consideration of actual "take" during research and development was slight.[15]

Two weeks later, ARPA approved "in general" the 30 January development plan but reduced the funding total from $148.2 million to $96.6 million for fiscal 1959. After further discussion of the details during March, the research project agency in April gave specific approval to the individual readout (E-1, E-2, E-3) recovery (E-5) and ferret proposals (F-1, F-2, F-3) but by implication withheld authorization for a mapping and charting photographic subsystem (E-4) which had earlier been grafted to the basic Sentry program. Unwittingly, the Ballistic Missiles Division had created a rival to an Army proposal for a covert mapping satellite program (known sequentially as Salaam, Vedas, and finally Argon) and had also begun to tread on the toes of an ARPA group which favored using a Thor booster to orbit an Army-Navy geodesy satellite. Inasmuch as each of these options was considered to be as sensitive as the closely held Corona program, relatively few at BMD knew of their existence. Nevertheless, arguments over BMD's "right" to develop a mapping satellite with or without ARPA's approval extended well into June, with the result that concern for the mapping satellite program (E-4) affected prospects for the recoverable reconnaissance satellite proposal (E-5).[16]

One of the basic difficulties in dealing with ARPA through the whole of 1959 was that agency's persistent effort to redirect the several military space programs toward objectives their military managers had not contemplated. ARPA still had not foresworn the goal of securing a manned satellite program for the military establishment--presumably to be under ARPA's immediate management control--even though Congress in activating the National Aeronautics and Space Administration the previous year had given a near monopoly in that field to the new civilian organization. In many respects, the military services, and particularly the Air Force, were in philosophical agreement with ARPA on the need for a broader military space program. Nevertheless, funds available through ARPA were scarcely adequate to support approved military space programs, and new efforts tended to divert attention from basic tasks. The budding E-5 recoverable satellite effort, for instance, was to some degree shaped by ARPA hopes that the capsule might be adaptable to housing a man. Although the Air Force at large was quite willing to gloss over peculiarities in size and environmental conditioning of the recovery capsule, being thoroughly in agreement with the ultimate objective of such misdirection, there was little doubt that the interests of satellite reconnaissance would have been better served by another course.[17]

Funding difficulties, largely caused by the proliferation and mounting costs of ARPA-sponsored space efforts, were principally responsible for a 25 May 1959 cancellation of the mapping and charting satellite (E-4) and the 23 June cancellation of the Sentry E-5 program. Such at least was the official explanation. The fact that the E-3 was continued, indeed that it was refined and submitted for development approval during the same period, tended to cast some doubt on the complete candor of the official justification for E-5 cancellation. By the same token, it was apparent that conflict and overlap between the E-4 and the Army-ARPA sponsored Argon mapping and charting satellite program was a factor in E-4 cancellation. The statement that funds originally scheduled for Sentry were to be diverted to "other ARPA programs" identified the cause of the action but did not fully explain its motivation.

Although ARPA directed only that the development of the E-5 recovery capsule be deferred pending a complete program review,* the effect of the order and a concurrent $25 million reduction in the level of Sentry funding was to halt all development activity. Work had actually started only after the 3 April approval of BMD's development plan and still was in a preliminary design status.[18]

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* Interestingly enough, the ARPA order to halt work on a recoverable E-5 capsule followed shortly after NASA responsibility for initial man-in-space experiments had been confirmed.

Objections from BMD, the Air Research and Development Command, and the Air Staff were both prompt and vigorous. By mid-July, BMD's commander, Major General O. J. Ritland, had personally taken his objections to General T. D. White, Chief of Staff, asking that the Air Force fund E-5 capsule development if ARPA continued to refuse. On 1 August, Lieutenant General B. A. Schriever (newly installed as ARDC commander) also appealed to General White to reinstate the E-5 program.[19]

The issue, somewhat oversimplified, was essentially whether readout or recovery techniques should be employed to satisfy the five-foot resolution requirement defined by the intelligence community the previous September. ARPA by effectively halting work on the E-5 capsule was ruling in favor of the E-3 (electrostatic tape system). Theoretically, the E-2 could, with substantial improvements in focal length and aperture, provide five-foot resolution, but all the objections to the basic E-2 technique remained in force. Unless very significant advances in readout technology were introduced, an "advanced" E-2 would be limited to taking and transmitting no more than 50 exposures per day for each available readout station. Each would cover, on the ground, an area of about five square miles. Requirements for extreme precision in satellite attitude, camera pointing, and basic targeting straddled the bounds of currently achievable technology, making practical (as opposed to theoretical) feasibility rather questionable. Against the only remaining alternative, reliance on the E-3, the Air Force could bring to bear all its contentions of unreasonable ARPA optimism, a high probability of program failure and the virtual assurance of very substantial program slippages, and a near certainty of inadequate image definition.* As for the question of whether five-foot resolution was a valid requirement, the Air Force based its case on a re-statement of intelligence needs furnished by the assistant chief of staff for intelligence.[20] The bones of the dispute were thus laid quite bare.

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* Lockheed stated the case for the E-3 in a proposal dated 29 July 1959. Apparently proceeding on the reasonable premise that ARPA's predeliction for readout would prevail over Air Force preferences, Lockheed painted the theoretical advantages of the E-3 in highly attractive colors. The contractor noted that E-2 technology was based on pre-1959 concepts and that the "recent addition" of a requirement for five-foot visual reconnaissance had prompted attention to state-of-the-art improvements. In Lockheed's opinion (at least, in its 29 July 1959 opinion!), "an all-electronic approach would "provide the highest possible performance in the earliest time period at minimum cost." Noting that the "technical feasibility" of electronic tape systems had been proven under Aeronautical Research Laboratory (Wright Air Development Center) contracts, Lockheed cited the availability of 100-lines-per-millimeter definition (12,200 television lines for a 61-millimeter-square format!), an equivalent sensitivity of ASA-145 (standard reconnaissance film had an ASA sensitivity rating of 2 to 5), and a readout system substantially simpler than that of the E-2. The image was to be recorded on photoelectric-sensitive electrostatic tape, read out by deflecting the modulation of an electron beam to scan a portion of the tape, and the video signal amplified and then applied as a modulating signal for transmission to ground station. A bandwidth of 12 megacycles per second was required (tubes had to be developed also) to provide a readout time of 8.7 seconds per frame. In such terms, ARPA's interest was entirely understandable.

As it happened, Air Force views stood a better chance of acceptance in the August-September period of 1959 than at any time over the previous 18 months. For a variety of reasons--stemming mostly from widespread dissatisfaction with ARPA's management of space programs for which the individual services had technical responsibility--ARPA's influence was gradually declining. Virtually the final chapter in the orgy of special-agency generation that began in October 1957 was the 1959 creation of a Directorate of Defense Research and Engineering (DDR&E) and its placement one echelon above ARPA in the Department of Defense heirarchy. Air Force Assistant Secretary, J. V. Charyk, who had recently replaced Horner in the research and development assistantship, cannily chose to present the case for the E-5 to DDR&E rather than to appeal again to Johnson and his associates. (Dr. H. F. York, who was named director of the research and engineering agency, had formerly been Johnson's deputy but had also been at odds with the "official" ARPA position on several key issues.) Charyk in a 26 August memorandum pointed out that adding E-5 development to the fiscal 1960 Samos* program would raise program cost by only $17 million, a price that seemed entirely reasonable for the product.

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*ARPA renamed Sentry on 6 August, specifying Samos because it was a name without "mission association." Although Samos was the name of

Whether Johnson moved on his own initiative or was prodded remained uncertain, but ARPA on 4 September 1959 finally authorized the award of an E-5 camera development contract "to protect schedules." (Notably, development of a recovery capsule was not simultaneously approved, and the E-5 camera was in some quarters considered adaptable to a readout system if that proved necessary.) Concurrently, however, ARPA directed that the earlier $143 million figure for fiscal 1960 Samos program expenditures be scaled down to a maximum of $135 million. Protests were again prompt, and again effective. Five days later, on 9 September, ARPA formally authorized reinstatement of E-5 subsystem development, including the capsule, and added $12 million to the earlier authorization total. The approved funds, however, amounted to $17 million less than the BMD "minimum requirement" and fell $12 million short of Charyk's estimate of minimum needs for fiscal 1960.[21]

Even though approval of the E-5 was a major victory for the supporters of capsule recovery techniques, the net effect of the maneuvering which had extended from December 1958 to September 1959 had

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a Greek island in the Adriatic Sea, it was promptly interpreted as the acronym for satellite and missile observation system--an absurd misnomer which nonetheless was later used in a variety of official directives.

begun to confuse program status so thoroughly that little real progress in E-5 development was possible. Although General Schriever protested to General White that Pentagon-instigated funding and program fluctuations had been chiefly responsible for that situation,[22] the explanation was not that simple. In point of fact, the Air Force had devoted nearly as much attention to securing approval of the E-4 proposal as to furthering the E-5 program, and disapproval or partial approval of Air Force development plans had been in large part conditioned by strong defense department objections to Air Force operational concepts which the junior service stubbornly supported.

Although the Strategic Air Command had originally been highly skeptical of claims that satellite reconnaissance could produce operationally useful results,* once Sputnik I made it clear that the Soviets had a highly potent rocket and missile program SAC developed an intense interest both in early flights and in acquiring early operational control of an eventual system. As in the ballistic missile program, where "initial operational capability at the earliest possible date" became more a fixation than an objective, development goals immediately became involved with operational readiness dates, operational sites, and plans for strategic command control of operational systems. The Ballistic Missile Division, which had responded to similar pressures on ballistic missile developments by "inventing" concurrency, a concept of interlocked development-production-deployment that actually was not applied to pre-1959 missile development efforts, unprotestingly applied the philosophy to the reconnaissance satellite effort. The effects on program size and cost projections were enormous. Readout, the dominant technical approach, implied that each satellite would require a minimum of three ground stations. Handling of multiple ground station products would necessitate the creation of a huge processing, analysis, and dissemination station (or several such stations), so concurrency actually implied the early development and construction of substantial numbers of elaborate and costly facilities.

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* Lieutenant Colonel Victor M. Genez, who had been associated with overflight reconnaissance programs since 1953, was fond of telling how his first presentation of WS 117L proposals to the Strategic Air Command staff had been received in 1954. Highly enthusiastic about the program, he had gone over its technical aspects, then based on television techniques, and had summed up with a fairly optimistic appraisal of its prospects. He finished. The audience turned its eyes on General LeMay, in the front row. LeMay clamped down on his cigar, glared at Genez, and growled, "Who in the hell authorized you to spend good travel money to bring this horse shit up here?"

Quite apart from the cost of such a program, concurrency and the prospect that the Strategic Air Command would operate Samos roused disquieting emotions in several quarters. Although both the developing and the prospective operating command proceeded on the premise that SAC operational responsibility for Samos was inevitable, it was not until August 1959 that Air Force headquarters formally designated SAC as the command responsible for operational planning for Samos and for processing "initial take." Shortly thereafter, all concerned were carefully advised that no specific planning date for transfer of Samos responsibility to an operating command was to be entertained for the moment. Nevertheless, concurrency remained an ingredient of BMD planning for Samos.[23]

One of the chief obstacles to acceptance of the basic thesis was President Eisenhower's clear directive that all United States satellites "must be advertised as being solely for peaceful purposes." Although the intent of the order had been diluted by a succession of Sentry-Samos publicity releases during 1958 and 1959, the Air Force nonetheless was obliged to make the pattern of Samos development conform to that ideal. At one point, Pentagon planners had proposed coupling all Air Force satellite launchings to such "peaceful systems" as Discoverer and Midas. The plan was thoroughly unsettling to Corona managers who had devoted months to the task of disassociating Discoverer from specific or implied military objectives. Samos had been so clearly identified with reconnaissance objectives that relating it to Discoverer seemed certain to compromise the covert Corona program. The prospect sent tremors down the teletype lines that connected the Central Intelligence Agency to the obscure Corona office in Los Angeles.

In December 1958, Air Force headquarters had devised a "cover plan" for Samos based on "advertising ARDC as both developer and operator." The scheme of making SAC operationally responsible for Samos was to be handled as Top Secret. Planning and programming for initial operational capability were to be similarly treated. In theory, this would satisfy the President's directive.

Accurately, if uncharitably, amused Corona managers concluded that the "AF cover operation" was so leaky that it would divert "a good deal of curiosity and attention" away from Discoverer-Corona and toward the acknowledged reconnaissance effort. And that was precisely what happened. The attempt to hide Samos under a Top Secret label after its reconnaissance potential had been openly discussed for months proved futile. The abundance of Top Secret clearances and normal human curiosity made almost every eligible staff officer in the Pentagon, in ARDC headquarters, and in SAC headquarters cognizant of the objective.*

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* In April 1959, a Pentagon presentations group took a revised draft of the "Sentry Cover Plan" to Undersecretary M. A. MacIntrye for his review. Before they had gotten well into their script, he interrupted

Thus when Air Force headquarters formally abandoned the attempt to deny that Samos existed and announced that the Strategic Air Command would ultimately be made operationally responsible for satellite reconnaissance, the problem remained quite as large as it had been eight months earlier. Nor were proposed solutions any more feasible. ARPA, in a particularly ill-timed maneuver, chose August 1959 to urge that all Samos shots be announced as Discoverers, a prospect that sent the Corona office into new tremors of despair. Like the earlier Air Staff suggestion of the same tenor, it was quietly deflated without harm to Corona security.[24]

Through all these petty twistings and turnings, SAC and the Air Staff persisted in their determination to make SAC operationally responsible for Samos, and particularly to give SAC both the ability and the authority to process and disseminate initial "take."* There

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and asked, rather impatiently, if they were familiar with the Corona activity. "When they said 'No,'" a Corona officer later reported, "he threw them out of the office." When one of the presentations group complained that the Sentry plan was "being interferred with" and was "butting blank walls" because of a "Corona program," it proved necessary to close him down without telling him any of the real circumstance. Colonel W. A. Sheppard, then Corona director, described the entire activity as a nuisance.

* Air Force headquarters also responded to pressures from operating commands by, at one point, proposing that the Air Rescue Service be assigned total responsibility for all retrieval operations arising from satellite reentry.

was in Air Staff intelligence quarters a peculiar reluctance to concede the necessity for proving out a research and development capacity in advance of turning over the system to an operating command, and there were some indications that intelligence chiefs in the Pentagon suspected ARDC of deviously maneuvering to retain custody of the entire system for an indefinite future. As had happened before, the using command and its Air Staff counterpart expressed resentment at the "refusal" of the research and development agency to be "immediately responsive" to operating command statements of requirements. A curious lack of appreciation of the fact that Samos was at best a high risk development and that it was still far removed from operational readiness was common to much of the Air Staff through early 1959.[25]

On the other hand, ARDC (and the higher levels of Ballistic System Division management) continued to support application of concurrency concepts to Samos development. There was no basic disagreement with SAC and Air Staff objectives, merely a difference in approach and in estimates of an operational utility date. Concurrency seemed the best possible compromise between the desires of the prospective operating command for early system availability and the ill-concealed conviction of some program managers that reconnaissance satellites were a new breed of weapons that could not be parceled out in the fashion of B-29's and KC-97's.

In the ballistic missile program, concurrency had meant conducting a broad front development and procurement program with the objective of deploying operationally useful missiles at the same time that launch sites and trained Air Force crews were available. Supporters of concurrency argued that no other technique could have carried the Atlas and Thor missiles so rapidly through the development and initial deployment phases. (In fact, Thor and Atlas were developed sequentially and the concurrency thesis was largely an after-the-event invention--but that too was irrelevant.) In any case, the applicability of concurrency concepts to programs other than ballistic missile development was not universally conceded. The question of whether concurrency was more costly than alternate processes could not be resolved to the satisfaction of all parties because there was no comparable "conventional" effort against which to measure costs. One effect of concurrency, however, was to compress expenses into a few fiscal years, and in those years the costs were unquestionably greater than in other broad-scope programs which continued over longer periods. Arguments that concurrency eventually brought lower expenditures in years after initial deployment were handicapped by the fact that all programs were funded on a year-by-year basis and that the long-term effect was of slight consequence to the current budget. The ballistic missile program was absolutely essential to national survival, a circumstance that no responsible official denied. But supporting a satellite reconnaissance program which might be quite as costly as a major missile development was another matter; many officials were quite skeptical of claims that such an effort was equally vital to survival.

Concurrency and its funding also entered the readout versus recovery dispute. Given the limitations of a readout system, relatively large numbers of both satellites and ground stations would be required to provide the reconnaissance coverage that intelligence authorities demanded. A successful recovery program would be much less costly. Fewer satellites would be required, and recovery satellite effectiveness was not at all dependent on the existence of expensive ground stations. In such terms, a recovery system, such as the E-5, had fiscal attractions independent of its technical promise.

Many program managers had reservations about the applicability of concurrency concepts to any reconnaissance satellite development. Those officers immediately responsible for the conduct of the effort at BMD felt that technology still was too uncertain to support anything resembling a concurrent development-procurement effort intended to result in the early availability of large numbers of satellite or ground stations in any given configuration. A breakthrough in traveling wave tubes, recovery techniques, camera optics, electrostatic tape technology, or any of several other areas might set the entire effort on a new course and make obsolete both the satellites and the expensive fixed-facility ground stations built to support them. Nevertheless, the official BMD policy endorsed concurrency.

There were additional considerations of some importance--the reluctance of other agencies to concede to the Strategic Air Command anything resembling a monopoly in satellite reconnaissance operations and a counterpart reluctance on the part of national policy makers to assign military space systems to a command with SAC's "militant image." The "peaceful uses of space" policy lurked behind almost all consideration of the subject.

Whatever the merits of the various arguments, there was general agreement that real progress toward a useful reconnaissance satellite system had been disappointingly slight in the 20 months during which ARPA had controlled both the policy and the technical aspects of the program. The Air Force rejoiced, therefore, when Secretary of Defense Neil McElroy, on 18 September 1959, authorized the reassignment of Samos to the Air Force. The date of transfer, however, was made conditional on the submission of acceptable development and operational plans.[26]

Hopes that McElroy's decision might resolve all of the outstanding uncertainties of the Samos program were quickly dispelled. ARPA influence declined promptly, and there were clear indications that the fiscal 1960 program would be funded at or about the "minimum requirement level" earlier specified by BMD, but in other areas confusion seemed to be compounded rather than eliminated. A revival of plans to quickly transform Samos into an operational system under SAC was immediate. Air Force headquarters issued instructions that the procurement of equipment which would permit operating commands to assume control of reconnaissance take was to be an early order of business. The Air Staff defined a role for the Air Photographic and Charting Service. In October, there was a careful discussion of SAC requests that research and development equipment required for the support of both ferret and photographic reconnaissance for Samos be transferred immediately to Offutt Air Force Base.[27] All in all, it was apparent that much of the Air Force viewed the removal of the ARPA yoke as a signal for return to air staff control and vigorous operational command participation in management of the development effort.

Such expectations proved ill-advised. DDR&E stepped into the void left by ARPA's removal and damped hopes of a large-scale development program built around concurrency concepts. The Air Force was advised that "internal reprogramming" would be required to provide funds for Samos development. Meaningful program control did not return to the Air Staff. Neither did either the division or the command level regain full authority. Instead, effective management authority passed upward one echelon, from Johnson of ARPA to his new superior, York of DDR&E.

Moreover, where ARPA had discouraged E-5 development and urged acceleration of the readout program, DDR&E swung to the opposite track and endorsed complete redirection of the program toward recovery and away from readout. BMD, which for the first eight months of 1959 had contended mightily for approval of an E-5 program, now found itself protesting against an apparent desire to abandon all other options. By early November, DDR&E had formally instructed the Air Force to emphasize and accelerate recovery subsystem development and to devote increased attention to problems of improved reliability and extended on-orbit life. BMD and Air Staff protests met a solid wall of resistance. Bowing to the inevitable, recognizing that formal transfer of Samos to custody of the Air Force was contingent on acceptance of the DDR&E viewpoint, the air secretariat on 6 November agreed to incorporate the revised policy into its Samos plans. Eleven days later, the Secretary of Defense officially transferred Samos management responsibility from ARPA to the Air Force. 28

Although the transfer agreement of November 1959 included a policy statement emphasizing that recovery should be pursued more diligently than readout, BMD continued to balk. The division protested that the near abandonment of readout mode development implied by Pentagon directions would delay availability of an early operational satellite reconnaissance system by 14 to 20 months--until sometime during the first half of 1963. In lieu of reducing the readout effort to provide funds needed for acceleration of the E-5 program, BMD urged continuation of both the ferret and photographic readout systems at their previously established rates and the provision of about [redacted] additional in fiscal 1961 funds to support an accelerated E-5 effort. The Strategic Air Command, the Air Defense Command, and the Assistant Chief of Staff for Intelligence attempted to reinforce the BMD stand by insisting on the urgency of early readout system operation, but both the strategic and the defense commands professed inability to recommend program reductions in their own areas which would release the required funds. At that point, the Air Force Ballistic Missile Committee took a hand, instructing BMD to submit a program that emphasized pohtography rather than ferret subsystems and which clearly concentrated on recovery rather than readout data retrieval methods.[29]

One immediate consequence of the redirection was to eliminate some effort covered by existing contracts. Included in the termination package that BMD and Lockheed worked out early in December were all of the very advanced readout programs--E-3 and F-4 (a ferret package development comparable to the E-3 in complexity and technical uncertainty). Other items deleted from the basic Samos effort, though not necessarily from the total Air Force space technology program, included the development of high-energy batteries and a solar-power-source backup to the auxiliary electrical power system, the nuclear auxiliary power development (SNAP), orbit adjust subsystems for Agena, an Advanced Photographic Readout (APR) project (the five-foot-definition "advanced E-2") and the development of auxiliary retro-rockets for the E-5 capsule. Formal training of Air Force personnel for operational duties in Samos "squadrons" was another casualty.[30]

Insofar as elimination of the E-3 and continuation of the E-5 resolved the long festering question of whether reconnaissance (as opposed to spot surveillance) should be based on a readout or a recovery mode, the redirection of November 1959 gave the total Samos program greater stability and solidity than it had possessed for nearly two years. But though the technological objectives of research and development could now be more clearly defined, as much could not be said for the end goal of the program.

More than recovery _versus_ readout was involved, though the apportionment of effort still was subject to change. By December 1959 there were clear signs that the SAC-dominated planning for early operation of Samos would meet with strong opposition from DDR&E. In the view of that agency, the entire course of Sentry-Samos development since April 1958 had been unrealistically oriented toward an attempt to create an early operational capability. The Director of Defense Research and Engineering, Dr. York, openly cautioned the air secretariat in early December 1959 that "such efforts would inevitably interfere with the research and development program and . . . have the effect of delaying the overall program." York said frankly that in his opinion Samos had been "confused and slowed down" by concentration on operational requirements well before the actual capability of the system had been established in a development form. He urged that funds scheduled for operational aspects of the Samos program be withheld, that the Air Force cancel its plans to train operational personnel, to acquire land and facilities, to construct expensive data links, to build operational launch sites, and to provide "equipment" required to process the Research and Development outputs in an attempt to provide operational warning.

It was also clear that York entertained strong doubts about the technical validity and the emphasis on the readout approach then supported by the Ballistic Missile Division and the Air Staff in general. He favored increasing effort on the E-5 because of its probable edge in feasibility and reliability over the E-2, and he urged that the development of Subsystem I (the ground processing and dissemination system) be curtailed because of its alignment with systems and products that did not then exist--and which might well prove impossible to develop.[31]

If the Air Research and Development Command, the major operating commands, and most of the Air Staff seemed little impressed with arguments against either readout or the concurrency-early operation thesis, it was also evident that Assistant Secretary Charyk was sympathetic to the DDR&E viewpoint. Moreover, by early December it was apparent that return of Samos to Air Force management channels did not by any means imply a reversion to "conventional" processes of review and approval at successive echelons, including the air staff, before programs were scrutinized at the secretarial level. On 2 December, Charyk countermanded instructions that would have sent the pending Samos development plan directly through the air staff and the ballistic missile committee on its way to "final approval" by DDR&E. He specified his intention of reviewing preliminary plans and of issuing specific instructions concerning their content before they were submitted for final approval.[32]

Taking cognizance of negotiations, presentations, and policy guidance statements that continued through much of December 1959 and January 1960, BMD on 30 January submitted a revised development plan that nominally conformed to the general outline of DDR&E instructions but which somewhat surprisingly retained major elements of the earlier approach. In essence, BMD had grafted a 7-flight E-5 program to the earlier 18-flight readout and ferret program. Eleven of the 18 flights were programmed for E-1 and E-2 subsystems. Moreover, concurrency, early operation, and Subsystem I were prominent in the operational annex.

Notwithstanding the content and implication of the 30 January plan, Air Staff confidence in the probability of securing funds to continue support of the readout and concurrency aspects of Samos had been shaken. Events of February tended to confirm doubts that the plan would be approved. Although the Air Force Ballistic Missile Committee on 15 February approved both the research and development program and the development-operation program proposal, defense secretariat reviewers withheld authority to proceed with anything more than the minimum research and development effort. For the moment, BMD was authorized to continue along the lines of the proposed research and development schedules, but a final and formal funds authorization did not emerge from the Pentagon during February.

Marshalling arguments to support its stand, the air staff in mid-March concluded that unwarranted confidence in Corona was partly to blame for the failure of DDR&E to endorse the "early operational" Samos program. Some $60 million was needed in fiscal 1960 to proceed with plans for a readout complex that presumably would, in conjunction with the E-2, fill the gap between the U-2 program, with its range limitations, and the actual need. In the light of the current uncertainty concerning Corona prospects, it seemed to the air staff that a case might be made for substituting the Samos readout system for an extended Corona effort. An analytical comparison between Corona and Samos might aid Air Force objectives, although the air staff conceded that by all available indicators York and his deputies would continue to oppose the authorization of "initial operational capability funds."[33]

Dr. Charyk, who had escorted the 30 January plan through most of its Pentagon review, on 18 February asked York to approve its research and development elements. York's response, delayed until mid-March, expressed the conviction that expanding the program by stacking on recovery subsystem flights was an insufficient reorientation. Not until 20 April did he issue a formal ruling, and then it consisted of another of the familiar "in principle" approvals that had marked Samos progress for more than two years.

Even more firmly than had been the case in December, Dr. York brought into focus the anti-concurrency, anti-readout arguments that had begun to appear more than a year earlier. He insisted that answers to questions of technical feasibility might well have been available by early 1960 if program managers had not channeled their attention toward considerations of operational facilities and hardware procurement. He wanted a halt to the expenditure of funds on "operational aspects"--and by the phrase he meant personnel training, technical operations centers, multiple readout stations, operational launching facilities, and virtually all of Subsystem I. The difference between this and earlier statements of the same tenor was that Dr. York was now in a position to enforce his desires; DDR&E held the purse strings! The program was approved at a research and development funds level of $159.5 million for fiscal 1960 (the fiscal year had only 10 weeks to run, but it had been operating since December 1959 on a "programmed" but unapproved level identical to that approved in April) and [redacted] fiscal 1961. The 1961 total represented a reduction 1002 [redacted] the amount requested through the 30 January development plan, with the reduction to be concentrated in visual and ferret readout developments. Funds needed to support "concurrency concepts" had been detailed in the operational annex; they were not approved.[34]

Less than two weeks after Dr. York had in effect denounced the previous conduct of the Samos program, Soviet anti-aircraft rockets shot down Francis Gary Powers, his U-2, and the only existent overflight program that was actually returning intelligence information. Samos was completely overhauled in the succeeding six months. By November of 1960 it bore virtually no resemblance to the approved program of April. In many respects, that reorganization was rightly attributed to the effects of the 1 May incident, the U-2 affair. But it was impossible to escape the conclusion that Samos would have taken something of its later direction as a consequence of the York directive of 20 April, whatever the course of international events.

Certain facts and conditions were clear in April. The BMD viewpoint--continued emphasis on readout and continuation of "concurrency" principles in program management--had remained the most prominent element of each development plan presented to the Pentagon even though clear instructions to reorient the development toward a recovery-mode effort had been issued as early as November 1959. York and Charyk could quite honestly complain that program management had not been responsive to guidance from air secretariat-defense secretariat level. Whether justified or not, York was convinced that an Air Research and Development Command fixation with concurrency concepts was responsible for much of the programming difficulty of the preceding two years.

It was also apparent by April that Charyk, who had succeeded to the post of Air Force Undersecretary in February, was disillusioned with the "conventional" processes of program management. Starting in December 1959, he had personally shepherded program proposals in which he had less than full confidence through the "routine" review and approval echelons--only to discover at the end of the long road that his efforts had been barren.

In such an environment, both concurrency and readout were certain to be the targets of a major program reorientation. If the U-2 incident was immediately responsible for a significant program acceleration and expansion, experience of the preceding 18 months had to share responsibility for the direction of program reorientation and for the fact that the management structure as well as the technical objective was reshaped.

NOTES ON SOURCES

1. WDD Dev Plan, WS 117L Advanced Reconnaissance System, 2 Apr 56.

2. Presn, "New Horizon," Summary of dev concepts and status of 117L progm, prep by LMSD, 1 Mar 58, cy in SP Samos files.

3. RAND Rpt RM-1811, "Physical Recovery of Satellite Payloads--A Preliminary Investigation," 26 Jun 56, in SP Samos files.

4. Interviews, Col W. G. King, 19 Dec 62, and Col R.A. Berg, 16 Apr 63, by R.L. Perry.

5. RAND Rpt RM-2012, An Early Reconnaissance Satellite System, 12 Nov 57 and a revision, A Family of Recoverable Reconnaissance Satellites, same code and date.

6. Memo, Col F.C.E. Oder, Asst for WS 117L, to Col C.H. Terhune, D/Cmdr Weap Sys, BMD, 3 Mar 58, subj: Differences between 117L Thor and Atlas Launched Programs, in Terhune files, ARS 57-58, SSD Hist Div.

7. The "suggestions" were contained in single sentences of thick volumes. In the 1 Jul 58 plan, the sentence read: "To obtain intelligence earlier than previously scheduled, provide an interim system containing a detachable capsule which may be commanded (or programmed) to return with stored intelligence to an area from where it may be physically recovered." See BMD Dev Plan, ARS (WS 117L), 1 Jul 58, in SP Samos files.

8. Ibid.

9. Rpt, "New Horizons," prep by LMSD for WDD, 1 Mar 58, in Samos files.

10. The explanation and illustration are drawn from a composite of sources including discussions involving MajGen R.E. Greer, Cols J.W. Ruebel and R.A. Berg, LtCol V.M. Genez, and Capt L.G. Neuner; an undated paper in Gen Greer's files titled

"Anatomy of Readout" (probably prepared Dec 62); an unclassified Rand study by A.H. Katz, Observation Satellites. . ., 25 May 59; and Utility Tech Manual, "Samos Agena B Satellites and Reconnaissance" on the worth of readout as well as on the worth and real significance of the variously noted technical obstacles to readout. The arithmetical factors, happily, were subject to fewer varieties of interpretation than were the philosophical advantages and disadvantages.

11. GOR 80, revised 26 Sep 58.

12. Folder, ARPA Briefing, 16 Dec 58, in SP Samos files.

13. Ibid.

14. Memo, W.A. Tidwell (CIA), Chm, IAC Ad Hoc Comm on Commun, to Chm, Intel Advisory Comm, 29 Apr 58, subj: Report of Ad Hoc Committee on Communications, in Samos files, R&D-1 Hist Docum; memo, Capt R.C. Truax, USN, Mil Asst to Dir/ARPA, to R.W. Johnson, Dir/ARPA, 15 Sep 58, subj: WS 117L Requirements Review, in Corona files; ARPA Order 41-59, 7 Nov 58; memo, R.E. Horner, Asst SAF(R&D), to SAFUS, 3 Dec 58, subj: 117L Program Content Problems, same file; memo, R.W. Johnson, Dir/ARPA, to SAFUS, 4 Dec 58, subj: WS-117L Program, Sheppard files; memo, Johnson to SAFUS, 17 Dec 58, subj: Reorientation of SENTRY Program, in Samos file, Hist Docm '58.

15. Memo, Johnson to SAFUS, 17 Dec 58; Dev Plan, Sentry Space System, 30 Jan 59, prep by BMD, in Samos files.

16. Amend 10 to ARPA Order 9-58, 3 Apr 59; Amend 1 to ARPA Order 48-59, Amend 8 to ARPA Order 9-59, Amend 1 to ARPA Order 38-59, all 16 Feb 59; msg 0432, Col W.A. Sheppard, Dir/Corona progm, to R.M. Bissell, CIA, 30 Mar 59, in Corona files; TWX WDZW-5-31-E, AFBMD to ARDC 28 May 59, in SSD Hist Div files, Sentry, '59.

17. Lockheed officials admitted to MajGen R.E. Greer in 1961 that both the spaciousness and the pressurization features of the E-5 capsule had been influenced as much by the notion of adapting it to a man-in-space mission as by basic camera environment requirements. Col W.G. King, program director at the time the E-5 configuration was approved, had doubts that capsule habitation had been a major

factor in the design. Neither viewpoint is reflected in contemporary documentation, but there is general agreement that both ARPA and high Air Force officials favored a man-in-space program under Air Force auspices. Presumably by Air Force direction, Lockheed submitted a "Sentry MIS" configuration for consideration late in 1958, and it bore a remarkable resemblance to the later (1959) E-5 design. As early as October 1958, "special" ARPA technical groups were reviewing and redirecting the details of Sentry "Hardware," and were in some instances dealing directly with the contractor. Lockheed, in its turn, regularly exercised its precedent-endorsed privilege of making independent approaches to various offices in the Pentagon. On balance, therefore, motive, opportunity, and outcome support the conclusion that the E-5 design was indeed influenced, if not dominated, by man-in-space considerations that had little relevance to satellite reconnaissance requirements. Interviews, MajGen R.E. Greer, 4 Mar 63, Col W.G. King, 11 Mar 63, and LtCol John Pietz, 11 Mar 63, by R.L. Perry, Hist Div; projection slides, Oct, Dec 1958, prep by LAC, in SP Samos files, slide box #1.

18. Memo, R.W. Johnson, Dir/ARPA, to SAF, 25 May 59, subj: ARPA Order No 9-58, SENTRY Project, in USAF Mis and Sat Ofc files, Samos 59; TWX WDZW-5-31, BMD to USAF, 28 May 59; TWX AFSAT 52072, USAF to ARDC and BMD, 5 Jun 59 and WDZW 6-6-E, BMD to USAF, 8 Jun 59, same file; TWX DEF 961412, ARPA to ARDC, 24 Jun 59, in SSD Hist Div files, ARS 59; TWX RDGZWC-31-7-38E, ARDC to BMD, 31 Jul 59, in SP Samos files, Hist Docum, 59; ltr, LtGen B.A. Schriever, Cmdr ARDC, to C/S USAF, 1 Aug 59, no subj, in USAF Mis and Sat Sys Ofc files.

19. Ltr, Maj Gen O.J. Ritland, Cmdr BMD, to C/S USAF, 18 Jul 59, subj: Transmittal of Development Plans, in USAF Mis and Sat Sys Ofc files; ltr, Schriever to C/S USAF, 1 Aug 59.

20. Ltr, MajGen H.A. Watson, D/Asst CS/Intel, to Dir/Adv Tech, USAF, 7 Aug 59, subj: Intelligence Requirements for High Resolution Photography, in USAF Mis and Sat Sys Ofc files; presn, LMSD to BMD, 27 Jan 60, slides in SP Samos files, Box #3; LMSD Rpt, Sentry Program E-3 Reconnaissance, 29 Jul 59, in Samos files.

21. Memo, J.V. Charyk, Asst SAF (R&D), to DDR&E, 26 Aug 59, subj: FY 1960 ARPA Program; TWX DEF 964914, ARPA to SAF, 4 Sep 59; TWX DEF 965117, ARPA to SAF, 9 Sep 59, all in USAF Samos files.

22. Ltr, LtGen B.A. Schriever, Cmdr ARDC, to Gen T.D. White, C/S USAF, 15 Sep 59, no subj, in USAF Samos files.

23. Ltr, Gen C.E. LeMay, VCS USAF, to CinC SAC, 5 Aug 59, subj: Assignment of Operational Planning Responsibility, in SSD Hist Div files; Dev Plan, Samos R&D Program, 11 Aug 60; TWX AFDAT 89855, USAF to ARDC, 11 Nov 59, in SP Samos files.

24. Memo, Col W.A. Sheppard, Spec Asst, to MajGen B.A. Schriever, Cmdr AFBMD, 20 Jan 59, subj: Corona Program Report, in Corona files; TWX AFCGM TS 3665, USAF to ARDC, 5 Feb 59, in SP Samos files, Hist Docmn 59; msg 0267, Sheppard, Dir/Corona, to R.M. Bissell, CIA, 30 Dec 58, Corona files; msg 0394 Sheppard to CIA, 21 Mar 59; 0455, Sheppard to G. Kucera, CIA, 3 Apr 59; 0738, Col F.C.E. Oder, BMD, to Bissell, 6 Aug 59, all in Corona files.

25. Ltr, Col R.J. Quinn, Dir/Intel and Electronic Warfare, ARDC, to Col H.L. Evans, Dir/Sentry Proj Ofc, 11 Feb 59, no subj, and incls (notes on conf with AFCIN staff); TWX RDZAA-26-5-2-E, ARDC to BMD, 26 May 59, both in SP Samos files, Hist Docmn 59.

26. Memo, Neil McElroy, SoD, to Chm JCS, 18 Sep 59, subj: Coordination of Satellite and Space Vehicle Operations, in USAF Samos files.

27. TWX ASDA 85267, USAF to BMD, 23 Oct 59; ltr, MajGen M.A. Preston, Dir/Ops, DCS/Ops, USAF to Air Photographic and Charting Serv, 21 Oct 59, subj: ACIC Participation in SAMOS, in SP Samos files, Hist Docmn 59.

28. TWX AFC 78900, USAF to AFBMD, 2 Oct 59; ltr, Col J.L. Martin, D/Dir Adv Tech, to DCS/D USAF, 2 Nov 59, subj: Samos memo for Record, Maj H.C. Howard, Ofc of Dir/Adv Tech, 6 Nov 59, subj: SAMOS, MIDAS, and DISCOVERER Programs; TWX AFC 1328/59, USAF to all maj cmds, 12 Nov 59; memo,

J.H. Douglas, SAF, to SoD, 6 Nov 59, subj: Transfer of the SAMOS Development Program to the Department of the Air Force; memo, T.S. Gates, SoD, to SAF, 17 Nov 59, same subj; all in Hq USAF Samos file.

29. TWX WDZF-11-6-E, BMD to USAF, 17 Nov 59; Draft Dev Plan, Samos, prep by BMD, 1 Dec 59; Min of 42nd AFBMC Mtg, 14 Dec 59; TWX VC 5540, D/Cmdr SAC to VCS USAF, 16 Dec 59; ltr, MajGen J.H. Walsh, ACS/I, to DCS/D, USAF, 21 Dec 59, subj: SAMOS; TWX 98219, VCS USAF to CinC SAC, 21 Dec 59; TWX ADLPD-D-1, ADC to USAF, 4 Jan 60; TWX AFC 61416, USAF to ADC, 7 Jan 60; TWX VC 0206, SAC to VCS USAF, 9 Jan 60, all in USAF Samos files.

30. TWX LBZJ-11-15-E, BMC to LAC, 19 Nov 59; ltr, LtCol R.W. Yundt, D/Dir Samos, to BMC, 6 Jan 60, subj: Letter Contract AF AF 04(647)-347, Direction of Samos Effort; ltr, [redacted] LAC, to BMC [redacted] 3 Dec 59, same subj, all in SP Samos files, Redirection, '60.

31. Memo, H.F. York, DDR&E, to SAF, 7 Dec 59, subj: Intelligence System SAMOS, in SP Samos file, Hist Docmn 59.

32. Memo, J.V. Charyk, SAFUS, to DCS/D, 2 Dec 59, subj: DISCOVERER, SAMOS, and MIDAS; TWX AFDAT 95614, USAF to BMD, 7 Dec 59, both in USAF Sat Progm files.

33. Draft memo for SAF dispatch to SoD, prep by DCS/D USAF, 11 Mar 60, in Corona files.

34. Memo, H.F. York, DDR&E, to SAF, 20 Apr 60, subj: SAMOS, MIDAS and DISCOVERER Research and Development Programs and Development/Operational Plans for SAMOS and MIDAS Programs; draft memo, York to SAF, undated [approx 17 Apr 60], subj: Intelligence System SAMOS, both in OSAF file: Sat Progms; draft memo, York to SAF, undated, [approx 17 Mar 60], subj: SAMOS, MIDAS and DISCOVERER Research and Development and Development/Operational Plans for SAMOS and MIDAS Programs, same file.

V SAMOS: REALIGNMENT CONTROVERSY (1960)

The U-2 that on 1 May 1960 failed to complete an overflight from Pakistan to Norway was one of many vehicles of several kinds that had passed over some part of the Soviet Union, cameras and recorders operating, since the beginning of the cold war. It was, however, the first manned aircraft to come down so intact and so far inland that cover stories became incredible. Within three days, after various spokesmen for the United States had issued a succession of contradictory statements about the aircraft and its purported mission, it became known that both the U-2 and its surprisingly communicative pilot, neither much damaged, had fallen into Russian hands.

Although the President did not cancel the overflight program en toto, he ruled that the U-2 overflights of Soviet territory were to be suspended until further notice. He also assumed unqualified personal responsibility for the overflight decision and acknowledged that covert reconnaissance was a cornerstone of United States security policy. The counterplay of motives was impossibly intricate, ranging from a Presidential election campaign that was rapidly becoming more intense to an impending summit meeting and possible rapproachement with the Soviet Union.

Reaction in the United States ranged from Vice President Richard Nixon's "hard line" statement that the flights would be resumed later, to the unpreceptive comments of several politicians and many newspapers that overflight was an inherent threat to world peace. Nikolai Khrushchev, the head of Soviet government, used the incident as an excuse to wreck the summit meeting. The British, French, and West Germans maintained an embarrassed official silence but let it be known that they thought it both naive and gauche of a head of state to acknowledge his role in espionage. Communist bloc nations made enormous propaganda capital of the episode, with telling effect on neutrals. The hostility of world opinion, the nervousness of NATO allies (who appeared considerably less worried about the fact of overflight than by United States' handling of the consequences), the violence of Soviet reaction, and the domestic sensitivity of the question during an election campaign combined to insure against resumption of U-2 flights over Russia.*

In many respects, the timing of the U-2 affair was even more unfortunate for the satellite reconnaissance program than for either domestic or international politics. Corona had as yet produced no photography. In the face of a solidifying secretariat-level judgment that the Air Force was mismanaging Samos, that service stubbornly persisted in attempts to secure funds for an extremely costly and technically weak program that was unwisely based on the premise of concurrent development and deployment. Moreover, the Air Force had so completely relaxed earlier strictures on Samos publicity that the objectives, general time scale, and broad capabilities of the developmental systems were widely known. Tensions could not be relaxed by publicizing a new overflight technique to replace a discredited covert methodology.

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* They had not been resumed 10 years later, mostly because the August 1960 success of Corona [redacted] made resumption ~~a~~ moot ~~question~~.

Even before the U-2 affair worked its effect in mid-1960, massive disenchantment with the Air Force viewpoint was common to the paneled offices along the Potomac face of the Pentagon. In March, the Air Staff had urged the Secretary of the Air Force to advise the Secretary of Defense that "the change of emphasis in development of resolution from 100 feet to 20 feet to 5 feet and from recovery to readout then back to recovery . . . has resulted in an indefinite postponement of a target date for operational readiness of an electronic readout system," and that the continued failure of the Corona program justified a vastly expanded Samos effort. But again the emphasis was on a "conventional" effort aimed at early employment of the satellite by the Strategic Air Command. The implication that the Air Staff was attempting to exploit recurrent failures of Corona missions to the advantage of Samos was unmistakable.[1]

Even before the U-2 incident brought reconnaissance needs into sharper focus, DDR&E and Undersecretary Charyk had explicitly rejected the Air Staff viewpoint. Continued Air Force advocacy of a politically dangerous, technically risky, and very costly approach chiefly served to convince policy level DoD officials that the Air Staff was incapable of appreciating the realities of the situation.

At the working level--in the Samos project office--there was keen awareness of the impossible situation into which the Air Force was edging itself. Through the early months of 1960, the project office chief (Colonel W. G. King) frequently protested that attempts to build concurrency into the program and to construct an elaborate logistic complex in support of the satellite effort were unwise. King at one point told his chief, Colonel F.C.E. Oder, that he believed the Air Force had been deliberately obstructionist in failing to comply with clearly stated secretarial guidance on Samos.[2]

Senior members of the Air Staff and chiefs of the major air commands were gravely concerned by the decision to end U-2 overflights and by the apparently slight prospect of obtaining an early substitute. Views on Corona ranged from troubled uncertainty to frank hostility. In more than a year of trying, the program had yet failed to return a single capsule safely, much less to provide reconnaissance information. Both those who knew of Corona and doubted, and those innocent of Corona knowledge, concluded that it was vital "to expedite and to develop fully the pre-operational photographic potential of Project SAMOS." On 9 May 1960, a week after the U-2 incident surfaced, that became at least a semi-official Air Staff position. One week later, following a lengthy meeting that involved Dr. Charyk, General Schriever, and Lieutenant General R. C. Wilson (Deputy Chief of Staff, Development), a formal directive embodying that philosophy went to ARDC.[3]

The implications of that stand, and its rationale, were both clear. All concerned unquestioningly accepted the premise that overflight was essential to U.S. security. A principal object of the U-2 operations of 1959 and 1960 had been to determine the extent of deployment of Soviet intercontinental missiles and, if possible, their locations. Khrushchev and other Russian spokesmen had been boasting of a Soviet intercontinental missile capability for many months. The evidence of Russian missile test operations and satellite successes appeared to support those claims. The United States, in early 1960, had deployed small numbers of Atlas missiles and somewhat larger numbers of Thor and Jupiter intermediate-range missiles (in Britain, Italy and Turkey). The Atlas, however highly touted in press releases, was at the time a singularly unreliable weapon of uncertain accuracy. Atlas missiles could not be quickly launched, the odds were against their functioning correctly if launched, and until launch they were susceptible to damage from virtually any nearby nuclear explosion. Thor and Jupiter were not much better technically, and were in exposed sites within easy range of Soviet bombers. Intelligence estimates credited the Russians with having more and better intercontinental ballistic missiles deployed over a broad expanse of Soviet territory, precise locations unknown. Nine successive attempts to obtain relevant information by using Corona had failed. The only other existent capability, U-2, had been negated by the effects of the Powers affair. Completion of the extremely elaborate Samos plan adopted in 1959 could not be anticipated before 1961 or 1962 at the earliest. Immediate and effective action of some sort therefore seemed essential.*

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* It is extremely important to view these events in the perspective of the time. The existence of a real Soviet intercontinental missile capability was generally accepted, as was Soviet willingness to resort to nuclear attack.

In many respects, the reaction of May 1960 resembled the furor of activity that followed the first Sputnik of October 1957. The emphasis lay on "maximum acceleration" of the program, with particular attention to "those aspects which offer a pre-operational intelligence return."[4] There was no apparent change of heart concerning operational concepts or concurrency, however, merely a suggestion that more money might be forthcoming. Since virtually all of the funds requested for research and development had been earlier approved, the implied goal of the program acceleration was to obtain previously denied funds for operational installations.

Colonel King, who had been connected with the Samos program in some role virtually since its inception, had strong reservations about the wisdom of any sudden spending splurge, whatever its motivation. In a thoughtful resume of program achievements and prospects, he noted that after four years of effort and the expenditure of nearly $750 million it seemed somewhat unrealistic to consider that establishing new programs would insure early reconnaissance coverage of the Soviet Union. He held that the rapid solution of fundamental technical problems was the real key to "obtaining intelligence at an early date." Increased depth and flexibility in existing programs seemed to offer the best prospect for program success. Having experienced the frenzy of the

1957 period, King was cautious about "substituting the gross optimism that accompanies new programs for the cold realism of existing programs." He was particularly disturbed about the widening gap between the Air Force and DDR&E viewpoints, particularly as they concerned operational plans, concurrency, and Subsystem I.

King urged several specific measures to improve the situation of the Samos program: (1) divorce the "classical operation, logistic, and similar considerations from the program now" (i.e., forget concurrency, cancel Subsystem I, eliminate operational-base programs); (2) remove the administrative handicaps which had inhibited program progress (i.e., create a clear and direct decision-action channel); (3) add a "back-up" recovery system and a new camera to the total program; (4) consider letting a new contract with some firm other than Lockheed; (5) expand ground testing activity; (6) examine alternate techniques of data retrieval, both for readout and recovery; (7) expand the test program by adding more launches to the schedule; (8) provide some means of determining Soviet weather in advance of photo missions; (9) re-examine both the basic Thor and the thrust-augmented Thor in combination with Agena stages as avenues to improved reliability and lower costs; and (10) increase the emphasis on land recovery techniques.[5]

Precisely the same problems were disturbing Undersecretary Charyk, who wrote General White late in May that the entire matter of operational command responsibilities, operational facilities, and the relationship between the operator of Samos and the data-using agencies still was a subject of "considerable discussion" in the defense secretariat. Charyk suggested that there was "some reason to believe that recovery rather than readout may well turn out to be the primary means for satisfying the bulk of the operational requirements." He noted that ground facility requirements would be "enormously simpler than if complete reliance is placed on readout." In Charyk's opinion, Subsystem I had been "greatly overengineered . . ."[6] On 27 May he acted on those views, instructing ARDC to provide for parallel testing of recovery and readout modes and explicitly directing that ARDC re-evaluate the use of off-the-shelf photographic equipment, or items in an advanced stage of development, as a means of accelerating recovery-mode flight schedules. Probably most significant, he directed that the E-5 recovery system get first priority in flight test, rather than the E-1 and E-2 readout systems, and that the F-subsystems (ferret) be further de-emphasized. Finally, he ordered that no more than a minimum capability for processing operational take be provided, with construction or purchase of ground equipment and facilities to be reduced to the lowest possible level.[7]

Early in June it began to appear that the resolution of Samos program uncertainties might be taken entirely out of Air Force hands. On the 6th of that month, Dr. H. F. York (Director of Defense Research and Engineering) instructed Charyk to submit Air Force recommendations on Samos program revision to DDR&E by the first week of July. York had been asked by the National Security Coucil how to accelerate the satellite reconnaissance program.[8]

On 10 June, President Eisenhower formally instructed Secretary of Defense Gates to conduct an intensive analysis of the "scope, basis and feasibility of our reconnaissance satellite projects." The National Security Council, Eisenhower added, would be concerned not merely with the technical aspects of the program but also with the process for establishing requirements, the requirements themselves, the "effectiveness of control over the scope and characteristics of the operational system," and related topics. (Eisenhower's anxiety about the implications of assigning operational responsibility for overflight reconnaissance was obvious. He, and by implication the other members of the National Security Council, were gravely concerned about the international repercussions.)

The President's instructions eventually involved Charyk, Dr. John Rubel (York's deputy), and Dr. George Kistiakowsky (the President's special assistant for science and technology) in preparing a joint response to the National Security Council. But before they could so much as open their inquiry, the Senate Appropriations Committee added [redacted] to the fiscal 1961 Samos budget and publicly characterized the program as "a matter of national emergency" which should "move forward as rapidly as possible." Lyndon B. Johnson, Senate majority leader and a strong contender for the Democratic presidential nomination, began to urge a "crash program" for Samos.[9]

Most of the proposals thus far presented implied program acceleration by funding expansion, even though modification of Samos technical objectives had been suggested. Beginning in early June, increasingly frequent alternative proposals were voiced, all stemming from the premise that the existent Air Force program structure was incapable of carrying the Samos project to a successful conclusion in a reasonable time. Mistrust of Air Force motives and ability was particularly pronounced in discussions involving the Army and the Navy.

The most forthright statement of opposition to Air Force concepts was contained in a special study prepared under DDR&E auspices early in June. Its author, Dr. B. H. Billings,* having examined the current status, the past history, and the prospects of the Samos program, recommended radical changes. He flatly urged cancellation of the entire readout program, carrying the E-2 only to the stage of a technical feasibility demonstration. Billings maintained that the E-2 was not competitive with other conceivable reconnaissance systems because of its data link limitations, the impossibility of using it for oblique shots, and its inherent shortcomings when used at high latitudes and in a region of heavy cloud cover. He also came down hard on the E-5 recovery system, pointing out that it was too complex and that a simpler technique would probably give a better prospect of reliable operation.

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* Various presentations of the Billings study continued through July, but the core of the recommendations was available as early as 6 June 1960 in the Pentagon, and had reached the West Coast by 13 June.

Billings concluded that the Air Force concept of Samos operation was entirely wrong. He argued that it would be a grave error to make the Strategic Air Command the proprietor of the system. In Billings' view, Samos was essentially a pre-strike reconnaissance device and as such should be assigned to a joint intelligence center of some sort. The need, Billings pointed out, was for a national intelligence capability, not for another SAC system. The Strategic Air Command needed targeting information, not raw, unevaluated data. Moreover, Dr. Billings could see no need for the construction of special processing facilities, noting that the existent structure was expandable at considerably less cost, and with a promise of being substantially more flexible.

In Billings' opinion, Samos was headed down the wrong path. He was convinced that a recoverable surveillance system, one that provided broad area coverage with ground definition of 50-foot objects, was needed to supplement the reconnaissance potential of the E-5. He also made the point that system operating costs would be very substantially reduced, perhaps by [redacted] year, through the substitution of a recoverable satellite for the readout system of the E-2.* And by implication he expressed doubt that the existent Air Force structure was capable of managing the necessary transition to a new concept of satellite reconnaissance.[10]

The philosophy implicit in the Billings' study represented little that was novel or unique. For weeks, York and Charyk had been increasingly critical of Air Force management of Samos. The continued emphasis on concurrency and on early turnover to the Strategic Air Command was contrary to Department of Defense policies stated in late 1959 and frequently reiterated thereafter. In six months of directed reprogramming activity, the Air Force had yet to produce a development plan acceptable to secretariat-level policy makers.

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* In the opinion of Colonel W. G. King, then Samos Project Director, Billings was more influential than any other individual in prompting the demise of the readout mode. It is worthy of note, however, that Colonel King and certain of his project officers had been dubious about the long-term worth of available readout systems for some time and had made themselves quite unpopular in some quarters by insisting that Corona represented the proper approach to satellite reconnaissance.

Even the most radical of the Billings suggestions, that Samos development be assigned to some "super agency" for management, was in many respects no more than a logical extension of established trends. The development of virtually all high-risk systems of the previous two decades had been "managed by exception" to some degree. The B-29 program of 1940-1944 had set a pattern in having special priorities and access to the highest decision levels. The Manhattan Engineering District of World War II had carried that process to its greatest limits. "Invention" of the "single prime contractor concept" in 1951, and its quick evolution into the "weapon system concept," together with the creation of "weapon system project offices" after 1951, had been motivated by a desire to cut through several review and approval layers in the existent decision process. General Schriever's Western Development Division of 1954-1955 had been created with a single system objective as its goal and with provisions for abbreviating the decision process in order to insure early success. The more recent example of the Polaris missile was at hand. Indeed, in some ways Schriever had attempted to build the "management by exception" theology into the whole of the Air Research and Development Command structure during a 1959 reorganization, though he channeled the communication and decision lines through his own headquarters rather than the Pentagon.

Strong suggestions that the methodology of Samos development might undergo a change were paralleled by a significant shift in the basic objective of the satellite reconnaissance program. On 5 July 1960, the United States Intelligence Board (USIB) issued a revised set of requirements based on the premise that national interest required the development of "an operational satellite reconnaissance system with a wide range of capabilities." USIB considered the "first and most urgent priority requirement" to be "a photographic reconnaissance system capable of locating suspect ICBM sites." Recommending a system with a 20-foot ground resolution potential, the board urged that the development program be oriented toward completion of development by the end of 1962.[11]

The new requirements statement was considerably more meaningful than it seemed at first glance. It completely reversed 1955 and 1958 policy statements on the prime goal of satellite reconnaissance, and in so doing virtually doomed the readout program. There was no feasible way of exploiting current readout systems to provide both the resolution and the area coverage implied in the new requirements.

Reconnaissance, which differed from "surveillance" in that it involved scanning broad land areas, could not in practice rely on a readout system capable of returning only 50 or 60 individual photographs each day. Gross coverage, in relatively fine detail, was an obvious essential, and gross coverage was quite beyond the potential of the E-2. For that matter, the E-5's ground-scan potential was too slight to satisfy the reconnaissance requirements of July 1960. What was needed, it appeared, was a new moderately high resolution system with panoramic-scan capability.* And unless a significant breakthrough in readout technology came at once, the new system would of necessity have to embody film recovery techniques.

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* Although the bald statement seems preposterous, it is nonetheless true that the chief of Air Force intelligence, Major General J. H. Walsh, either could not see or would not admit that the new requirements statement completely changed the status of the satellite reconnaissance effort. To a query from Charyk concerning the differences between the 5 July USIB statement and previous requirements statements, Walsh replied, "There is no change in the intelligence requirement." General Walsh, who represented the most extreme of the SAC-oriented viewpoints in the 1960 Pentagon struggle over Samos, also tended to approach the Corona versus Samos problem with something less than complete objectivity; he seemed to view Air Force officers who looked sympathetically on Corona as guilty of some sort of organizational treason. To single out General Walsh as a horrible example of what may be taken as an outlook typical of much of the Air Staff is perhaps unfair--but General Walsh took special pains to insure that his prejudices stood out prominently.

Additionally, by emphasizing classical reconnaissance rather than either surveillance or early warning, the new requirements degraded the importance of the concepts that had governed Samos technology virtually since program inception. If reconnaissance akin to that of the U-2 was to be the program goal, neither concurrency nor operational control by a combat command would be needed. In many respects the July 1960 requirements statement seemed to have been more influenced by the philosophy of the Corona approach, with its special management and technical character, than by any established ground rules of the existent Samos program.

Among factors that could not be ignored in program reorientation were considerations of contractor performance. In this instance, the continued failure of the Discoverer-Corona system to return photographs, a feeling that Lockheed was at least partly at fault, and the fact that the Aerospace Corporation was then coming into being as a not-for-profit successor to Space Technology Laboratories all contributed to what was, in the main, a subjective judgment. In the extant Samos structure, Lockheed was the only major "system contractor"--as opposed to the "associate contractor" arrangement common to the ballistic missile program. In comparison to the relatively successful missile development efforts, Samos could scarcely be characterized as a flourishing program, and it was not difficult to ascribe some of the fault to the fact that Lockheed had both hardware and system engineering responsibilities. If an "independent" systems engineering contractor (Space Technology Laboratories) had done so well for missiles, might it not be worthwhile to try a similar approach for Samos? If, at the same time, Aerospace Corporation got a chance to display its talents and to establish its reputation, so much the better.

Whether justified or not, the frequency of suggestions that another contractor be brought into the Samos program seemed to confirm the existence of a general anti-Lockheed feeling.

The turning point came on 29 June with General White's advice to General T. S. Powers, Strategic Air Command chief, that plans for an elaborate Samos complex at Omaha were being dropped and that SAC could expect to receive Samos data as it did other intelligence information. Samos, said White, would be an Air Force rather than a Strategic Air Command system.[12]

On 12 July, the Ballistic Missile Division submitted for Pentagon review and approval a revised development plan which incorporated much of the York-Charyk philosophy, the Billings recommendations (modified), and the USIB requirements statement.[13] Among the major innovations were a proposal for a new recovery system and camera, a recommendation that the contractor structure be expanded, plans for more frequent launchings (and the use of boosters other than Atlas), deletion or transfer of Subsystem I development, curtailment of the ferret program, simplification of photographic equipment, and similar modifications earlier suggested by Charyk, York, Billings, and Colonel King. BMD also proposed expanding the scheduled test program to 30 orbital launches (from 25), with 19 of the total to be film recovery operations. The funds requirement was estimated at [redacted] for fiscal 1961, or the total of the administrations' budget request plus the funds added by Congress.[14]

First to review the BMD-proposed plan was the Air Force Ballistic Missile Committee, which further increased the proportion of recovery-mode tests and approved the addition of a three-pad Samos launch complex at Point Arguello.[15] Directorate of Defense Research and Engineering, the next key review point, authorized the start of work on the new launch complex following an 18-19 July appraisal, but withheld full approval of the plan. Processing and dissemination uncertainties remained to be resolved.[16] Immediately thereafter, Undersecretary Charyk directed BMD to revise its 12 July development plan to provide for eight tests of the readout-mode satellites (photo and ferret combined), a total of seven E-5 tests (including two diagnostic flights, if required), and seven in the "new recoverable photo payload..." configuration. Additionally, Charyk authorized the inclusion of five unassigned Atlas-Agena vehicles in the total, to be used for diagnostic flights of the "new payload" satellite if needed.

The "new program" was to incorporate a new recovery system (differing from both the E-5 and the Discoverer-Corona) and a camera designed for gross coverage at the "best ground resolution that state-of-the-art will support." Moreover, the new system was to be sufficiently flexible to permit payload switching if that later seemed advisable.

Air Force headquarters promptly passed along Charyk's directions to ARDC and authorized the immediate start of a source selections process for the "new payload."[17] The Air Staff instructions that authorized BMD to act on such guidance also included specific directions to exclude all Subsystem I and all processing facility provisions from the revised development plan (due by 8 August).[18]

General Schriever interpreted the Charyk dictate to mean that the creation of a reliable recovery system was the "single most important development" for the nation, USAF, and ARDC. He concluded that the overhauled satellite reconnaissance program would have four discrete but correlated facets: Corona, Samos E-5, Samos with the new payload, and a separate recovery system. He also believed that the elimination of operational-logistic complications and the proposal for a new payload-recovery system which satisfied USIB requirements had counteracted suggestions that Samos management be reassigned outside the Air Force.[19]

But even as General Schriever was realigning the Samos approach within ARDC, another DDR&E panel was in the process of submitting a highly critical appraisal of Air Force management of Samos. On 19 July a special advisory group headed by Dr. W. O. Baker of Bell Telephone Laboratories, reporting to Dr. York, harshly rebuked the earlier emphasis on readout over recovery, the role of the ferret effort, the prematurity and complexity of Subsystem I, the concurrency approach, and several technical facets of the program. The Baker group's proposed solution was to assign all Samos program responsibility to an organization attached to the Office of the Secretary of Defense while permitting the Air Force to continue its technical management functions--but with the addition of personnel particularly well qualified in satellite reconnaissance technology.[20]

While the question of Samos management continued under examination in the Pentagon, BMD rapidly completed a draft technical work statement covering the "new payload" defined by Charyk. Requiring ground resolution of "20 feet or better," land recovery within five miles of a target point, and high system reliability, the work statement specified a high acuity camera subsystem combined with a "new reliable re-entry and recovery subsystem," the whole to be capable of providing large area coverage throughout an eight-day orbital life.*

The subsystem thus defined had by late July acquired E-6 nomenclature. A revision of the basic development plan was in process, incorporating the technical guidance provided by DDR&E, Charyk, and the Air Staff. But there continued to be uncertainty at all levels concerning the final management mode. USAF headquarters consistently described Samos as a national program conducted by the Air Force, although it was readily apparent that this adroitly phrased euphemism was not being accepted at face value by the other services or by DDR&E. Discussions within the Joint Chiefs of Staff structure and between the Air Force and DDR&E never managed to quiet fears that the Strategic Air Command would secure the authority to control both Samos operations and the dissemination of any intelligence product.[21] Nor could it be denied that a vocal segment of the Air Staff continued to support SAC's sturdy claims that the command was rightfully entitled to such authority.

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* Although the work statement was in reality nothing more than an estimate of intentions, its details were more than casually related to the Baker group report of 14 July. The new proposal specifically provided a counter-balance to each of the major criticisms contained in the Baker

While the political cauldron bubbled, BMD attempted to put the technical aspects of the "new approach" in proper perspective. On 30 July 1960, General Ritland named a source selection board for the E-6, defined its task as determining the best contractors for camera and recovery subsystems, and expressly stated that the objective of the effort was to develop a photo-recovery version of Samos with broad area search capabilities and the highest attainable resolution.[22] It was ARDC's intention to exclude Lockheed from any aspect of the competition, partly to insure the creation of an alternate contractor approach, but also because of earlier criticism of both Lockheed and BMD management. Unlike the original WS 117L program and its subsequent subdivisions, the E-6 effort was to be conducted under the technical direction of Aerospace Corporation rather than with Lockheed as systems integrating contractor. The precise scope of the technical direction and systems engineering responsibility was, however, somewhat obscure late in July. General Schriever favored giving Aerospace less responsibility than Ramo-Woolridge had exercised during the early days of the ballistic missile program while others,

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report. That paper had specifically characterized the E-2 as obsolete, had objected to limitations in swath width and readout that made its orbital operation "economically and politically unacceptable," and had scored the E-2 on grounds of excessive complexity, too great sensitivity to precision requirements in photography, and entirely unrealistic expectations for ground resolution.

including Trevor Gardner, urged a full return to the operating principles of the original Atlas program. Eventually it was agreed that the best approach would be to review the total Air Force reconnaissance satellite effort, to re-appraise Department of Defense requirements, and to present the results of the study to a succession of higher authorities. In essence, the process was to be akin to the creation of another "Teapot Committee" like that which had prompted acceleration of the ballistic missile program in 1954.[23]

Part of the impulse for the creation of a "committee of scientific advisors" certainly derived from the increasingly forthright statements of a group of highly influential industry spokesmen, including some who then were serving in the Department of Defense. The "tong"--a term widely employed--had become convinced that the existent program structure would never support an aggressive, effective development effort. Memories of the confusion that had characterized the ARPA period of program control were fresh, and to many it appeared that restoring Samos management responsibility to the Air Force had brought no real improvement. The convictions of this group carried weight with both Charyk and York, and as expressed in the Baker Committee report were familiar to Schriever and the Air Staff. Many members of the "tong," which included officials from a variety of firms but was dominated by the photo-oriented companies, were particularly distressed by the failure of the Samos program to move away from the "conventional channels" characteristic of less pressing development efforts. They generally favored "management by exception" as a means of overcoming inertia in the existent multi-review program office structure.

General Schriever, then engaged in transforming several major ARDC programs into smaller replicas of the Atlas-Thor-Titan effort, had similar conceptions, though he naturally favored keeping Samos within the ARDC management structure. He suggested to the Air Force Chief of Staff, General White, that it would be advisable to name an Air Force general officer to head a new "management by exception" Samos program. Except for the question of what agency would have direct control of the Samos effort, there was by late July a high degree of general agreement on the need for a new management approach.[24]

Such parallel tendencies came together on Wednesday, 3 August 1960, when General White called Brigadier General R.E. Greer into his office and abruptly asked how he would like to become "Mr. Samos." Greer, who was then the Assistant Chief of Staff for Guided Missiles, a post slated for early abolishment, said mildly that Samos had always been one of his favorite projects and awaited developments. White told him to get in touch with General Schriever and to work out the organizational details of his new assignment. At the close of the brief conversation, the Chief of Staff casually asked the newly designated Samos chief if he had heard anything about "Eastman's big new camera." Greer, who was familiar with the background of Samos and who was one of the staff officers briefed on the covert Corona program, shook his head negatively and stored the information away for future reference.

Greer immediately contacted General Schriever, who was at Patrick Air Force Base participating in an ARDC Commanders' Conference, and on the following day (Thursday) flew down to the missile base for a personal meeting. He, General Schriever, and General Ritland briefly discussed possible organizational arrangements that afternoon, and Greer continued the discussion while flying back to Washington with Schriever that evening.

On the basis of the instructions Greer had received from White and in the context of the situation as it was then known, Greer, Schriever, and Ritland concluded that a structure resembling in general outline the Western Development Division of 1954-1955 should be created to house the Samos project. They tentatively agreed that General Greer should be named Vice Commander for Reconnaissance Satellites at AFBMD. General Ritland and General Schriever, in subsequent discussions, the following Friday and Saturday, concluded that some direct command line from the Samos office to the Pentagon was inevitable, but they agreed that it would be best to have that line run through the BMD commander rather than the ARDC commander. (General Schriever, when named to head the original ballistic missile program, had operated as a deputy commander of ARDC but with direct access to the air secretariat level.)

The nomination of General Greer as Samos chief and the subsequent proposals for alignment of the Samos office within the existing command staff structure were obviously intended to create an environment which would insure that Samos program responsibility remained under an Air Force aegis. Both Schriever and Greer were fully aware of the still-viable proposals to install the Samos program in some secretarial-level agency, either within the Department of Defense or the Department of the Air Force.[25] The matter was scheduled for a decision by the time of the 25 August National Security Council meeting, during which the Kistiakowsky-Ruble-Charyk team was to submit its recommendations. Inevitably, the team recommendations would be influenced by the revised Samos development plan, which reached final draft stage only on 6 August. Additionally, the E-6 source selection board process was then accelerating, and complications might well arise from its products.[26]

Attempting to precipitate a decision favorable to the Air Force viewpoint on managing the Samos program, Schriever on 6 August proposed the public release of a statement covering Greer's appointment and his assignment as BMD Vice Commander for Reconnaissance Satellites. The draft statement included a policy summary which said unequivocally that the Air Force was the executive agent for all concerned government agencies--including the Central Intelligence Agency and the National Security Agency--in the development of reconnaissance satellites. (One effect of the proclamation, upon its approval at the Department of Defense level, would presumably have been to bring the entire Corona activity under ARDC control.) The proposed release also emphasized the fact of Samos program acceleration and included an announcement that the reoriented effort was aimed toward the early development of recovery systems and associated camera techniques.[27]

The statement proposed by Schriever had enormous potential, extending well past the question of who would have organizational responsibility for Samos. If approved and published with a Pentagon imprimatur, it would have the effect of formally committing the United States to a policy of overflight reconnaissance, and of implementing that policy. It would allocate to General Schriever all effective authority over all American military satellite programs, making him responsible only to the Air Force Chief of Staff. Because operational authority would repose in the Samos program office, which would report through Schriever to the Chief of Staff, it would give Schriever's Air Research and Development Command ultimate control of development, operations, and (actually if not formally) dissemination of the returns of all satellite overflight intelligence.

While the policy implications of Greer's appointment were being explored and while the effort to fix Samos authority firmly within the existent Air Force command structure continued, new technical and financial aspects of the program moved toward approval. On 8 August, AFBMD released the official work statement requirement for the E-6 source selection and two days later notified Lockheed of the decision to exclude that firm from the prospect list. The revised development plan was published on 11 August. Based on a fiscal 1961 requirement of [redacted] and subsequent-year estimates of [redacted] respectively, it incorporated all of the Charyk-York guidance of June and July.[28]

Ballistic Missile Committee review of the revised development plan was scheduled for 15 August and National Security Council review--on the presumption of committee approval--for 10 days later. Until 12 August, the White-Schriever policy of assuming that the Air Force would continue control of the Samos program seemed sure of confirmation, but on that day cracks appeared. The official announcement of Greer's appointment said merely that he had been named BMD Vice Commander for Satellite Systems in order to increase the emphasis being accorded those satellites assigned to the Air Force by the Department of Defense. None of the proposed statements covering Air Force control of the reconnaissance satellite program were included, there was no mention of major policy decisions to emphasize recovery techniques rather than readout systems, and--most significant--reconnaissance satellites were not mentioned at all. At the least, the Defense Department had decided that a relatively minor press release was not the appropriate vehicle for announcing a major change in U.S. military and diplomatic policies.[29]

By 15 August, the decision to withdraw control of Samos from the Air Force had been made. At the conclusion of the Ballistic Missiles Committee meeting of that day, following the committee's endorsement of the 11 August Samos development plan, Dr. Charyk privately told Greer that ARDC would not retain program management authority. For several days, however, Greer did not know which of the various defense department or air secretariat agencies would have custody. Complete misconceptions of the true situation persisted at ARDC headquarters and in the West Coast BMD complex. General

Schriever and the ARDC group remained steadfast in their conviction that the program would somehow continue under ARDC control. In Los Angeles the prevalent belief was that Greer would become a sort of general director for what had originally been WS 117L--Samos, Midas, and Discoverer--while Colonel W. G. King, Samos program chief, exercised direct control of the main Samos program. The implication that Corona would enter conventional Air Force development channels as part of the "Greer reorganization" was not widely discussed in Los Angeles, but that outcome was anticipated by those aware of Air Staff views on Corona and of the major crisis in Corona technology.[30]

In Washington the inevitability of Samos management by some special agency was being privately conceded by midsummer. Major General R.C. Wilson, Air Force R&D chief, who worked closely with Charyk and who was well attuned to Pentagon trends, refused to surrender his faith in an eventual Air Force triumph until late July, even though he knew of Charyk's conviction that program control would be taken away from the military.

The three most prominent candidates to replace the uniformed Air Force as Samos managers were DDR&E, CIA, and the Office of the Secretary of the Air Force--in that order of probability. By conducting the Corona program so circumspectly that no hint of its existence had leaked out, CIA had made itself most eligible on the grounds of political discretion. But the conduct of such a broad scope program as Samos would be entirely foreign to CIA habits. That factor probably weighed against the intelligence agency as much as any other, DDR&E had the requisite position and authority, and had demonstrated a consistently better grasp of program realities than the current program proprietors. Indeed, for nearly six months DDR&E had been the de facto program manager, even though normal channels continued to flow with directives and responses. The Office of the Secretary of the Air Force had Charyk, whose personal interest in and knowledge of the program were certainly more profound than those of any other official in Washington, while Charyk's office could be represented to be an element of the Air Force, thus making it in some ways more acceptable to the Air Staff than any alternate agency. But so long as Charyk remained solely an Air Force official, widespread objections to Air Force control of operational aspects of satellite reconnaissance probably would be effective.

Charyk made the Samos presentation to the National Security Council on 25 August. He told the President quite frankly that satellite photographs would not for years provide the quality obtainable through U-2 overflights, but he outlined a reasonable approach to that objective through realignment and revitalization of the Samos effort. The presentation was perfectly timed to have the proper effect; within the previous week the first Corona photographs had been recovered and the physical proof that satellite reconnaissance could actually be effective was at hand.

A portion of the presentation was a recommendation from Charyk, Kistiakowsky, and Ruble that Samos be managed by an Air Force general officer reporting directly to the Secretary of the Air Force. (DDR&E had flatly refused to accept any arrangement that included intervening military echelons--and particularly ARDC.) The Samos management scheme outlined on 25 August also proposed that boards of technical experts be appointed to serve as program advisors while existent military organizations provided administrative, logistic, and technical support.[31]

The security council resolved virtually all known program uncertainties, reviewing and generally approving the 11 August development plan (with modifications made through direct contact between Charyk and the program office during mid-August), directing that the new recovery-mode subsystem (E-6) be developed under a high national priority, and endorsing a program objective based on the earliest possible accumulation of definitive information on the location and status of Soviet ICBM sites. Sea recovery was specified for initial systems, with land recovery to be provided later. Readout development was to continue only on a reduced scale, the ferret program was to be cut back, and Subsystem I was to be all but eliminated. Additionally, the President approved the programmed launch of the first experimental Samos E-1, then scheduled for 20 September. Specific approval of the flight had been withheld until that time, chiefly in honor of the "space for peace" thesis, and the Air Force had entertained grave fears that the political pressures of the time might induce a decision to postpone or even cancel actual launches.[32]

Although the Security Council ruling assigned program responsibility to the Secretary of the Air Force, it was obvious that the secretary, as an individual, could scarcely exercise direct control. The responsible official was to be Undersecretary Charyk, who as chairman of the Ballistic Missiles Committee was the administration official most thoroughly familiar with the Samos program. Not for another month, however, were suggestions of assignment to DDR&E finally disposed of.

On the day following the 25 August Security Council meeting, Charyk and Greer met to discuss the tenor and scope of required directives. That afternoon, General Greer drafted a sequence of papers for the signature of the Secretary.[33] They were issued as Secretary of the Air Force Orders on 31 August. One established an Office of Missile and Satellite Systems at the Secretarial level to handle administrative and liaison responsibilities with the Pentagon. A second named General Greer as Director of the Samos Project with additional duty as BMD Vice Commander for Satellite Systems. Greer was empowered to organize a project office by drawing manpower and support from BMD, but his establishment was clearly identified as a field extension of the Office of the Secretary of the Air Force.

In separate actions, Air Force Secretary D. C. Sharp created two advisory bodies--a Satellite Reconnaissance Advisory Group to be composed of technical experts and industry representatives; and a Satellite Reconnaissance Advisory Council to be composed of the four assistant secretaries of the Air Force, the Undersecretary, and Air Staff representatives.* Sharp additionally had the Air Staff assign Brigadier General R. D. Curtin (former BMD satellite program chief) as Director, Office of Missile and Satellite Systems, and transfer 20 specified officers, airmen, and civilians to Curtin's staff. The secretary's office, from its own resources, authorized 10 officers and 10 civilians for General Greer's group while BMD transferred 39 officers and 15 civilians to Greer's new West Coast organization.[34]

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* The advisory group never met. The advisory council held one meeting, formally approved several brief presentations, and never reconvened.

Although in some respects the events of 25-31 August appeared to eliminate any confusion concerning Samos program responsibilities, a faint aura of uncertainty persisted. For instance, when acting Secretary of Defense J.H. Douglas formally approved the modified 11 August development plan, he added a note indicating that "technical revisions" earlier discussed and any changes to the 11 August plan would require the final approval of DDR&E before the Air Force could act on them. Nevertheless, Douglas authorized the Air Force to start work on the [redacted] for fiscal 1961--a vast improvement over any earlier funding authorization.* Again, the operations plan earlier submitted was specifically exempted from approval.[35]

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* Through fiscal 1960, Samos development had cost between $353.2 million and $360.2 million (both figures were cited in various sources in mid-1960), of which $1.5 million had been spent on feasibility studies (Rand), $8.9 million for evaluation and program activation, $241.96 million for work by Lockheed (which paid subcontractors from that sum also), $29.6 million to buy Atlas boosters, and the remainder for various lesser expenses. Some [redacted] was scheduled to go to Lockheed and about [redacted] to Convair (General Dynamics) during fiscal years 1961, 1962, and 1963.

Further clarification of the intent of the 31 August orders and of the procedures that would be followed in program management came on 13 September. Secretary Sharp identified the authority-decision link between his office and Greer's with the explicit statement that "there will be no review or approval channels between the Director of the Samos Project and the Secretary of the Air Force," although "need to know" briefings could be scheduled at the discretion of the secretary. Additionally, both Generals Greer and Curtin were authorized direct contact with major commands, Air Staff agencies, and "other staffs and agencies . . . as required."[36] A final and explicit statement of the DDR&E role appeared two days later, when Douglas issued instructions that on Samos matters the Secretary of the Air Force would report directly to the Deputy Secretary of Defense--Douglas himself! DDR&E, Douglas explained, would serve as a "staff agency to assist the Deputy Secretary of Defense," and Air Force project managers would keep DDR&E informed of Samos events--but there was no provision for DDR&E review or approval in the basic directive. Greer would report directly to the Secretary of the Air Force (actually, in practice, to the Undersecretary--Dr. Charyk), and he to the deputy secretary of defense.[37]

On the same day, 15 September, the new Secretary of the Air Force Samos Project Office officially came into being on the West Coast.[38]

Notwithstanding all that, General Schriever and ARDC steadfastly refused to concede that Samos had been entirely withdrawn from the command's custody. As late as 19 September, General Schriever proposed measures that would "reaffirm ARDC's charter for the program." He urged on General White a modification of his earlier proposal for the creation of a Samos-equivalent to the Teapot Committee, a group to reinforce the scientific prestige of the Air Force viewpoint and to counteract such groups as the Baker Committee. Schriever also renewed his advocacy of a vigorous public release program, recalling to life a 1956-1957 proposal conceived by Richard S. Leghorn which had been instrumental in the generation of *Corona*. He suggested to General White that it might be advisable to confront the Soviet Union with a *fait accompli* by publicly sponsoring active satellite reconnaissance operations and proclaiming to the world that Samos was a device for insuring world peace.[39]

But even though ARDC was not yet ready to acknowledge the complete revolution in Samos management, the decisions had been made. A major consideration in the decision to exclude Samos management from any control by military elements of the Air Force was the President's insistence that the program be conducted most circumspectly. The national administration could not overlook the prospect that the Soviets might react to an "open" Samos program by making determined efforts to destroy reconnaissance satellites--or all satellites--and thus precipitate a new international crisis. A key to the rationale of the new Samos policy was the August 1960 success of Corona, which returned abundant and excellent reconnaissance photographs from orbit and vividly demonstrated the value of the product. United States' adherence to the "space for peace" theme was thus reinforced rather than weakened by establishment of Greer's organization. Nevertheless, within such limits Samos policy remained relatively flexible. Corona had proved that satellite reconnaissance was feasible. The real task of the new Samos program, then, was to expand, improve, and domesticate that feasibility.

the Air Force would have long-time-on-orbit satellites to operate. The P-35 vehicle was, of course, the first military satellite to be kept functional on a daily basis for so long a period, and it had certain peculiarities that set it apart from other orbiting devices. So did the program office. For one, the strictures of operating with a tight budget and with military personnel had prevented creation of a sophisticated communication system interlocking Los Angeles with Vandenberg, as was the case with other SSD space systems. All the data acquired from orbit had to flow through the 6594th Aerospace Test Wing before reaching the engineers who designed and built the spacecraft and ground equipment. There was no direct feedback of operational data from the tracking stations and the Satellite Tracking Center (Sunnyvale) to the program office. Both situations resulted from operating without a systems engineering/technical direction contractor. That novel arrangement also meant a shortage of qualified technical people to assist and advise the test wing during operations. The test wing, therefore, had to assume more initiative in the operation, analysis and evaluation of the program. In the eyes of the P-35 office, the only real difficulty in this unique system had been the failure of the test wing's people to report on the operation of the ground equipment. The ground equipment contractor operators were employed by RCA and were responsible to the wing rather than to the program office, but they were under contract to the program office, and the program office had an obvious need for detailed data on equipment operation.

Early in the operation of the bird (which by October was known by its fourth new designator: Program 417), an old military problem nosed into the space program for the first time. Maintaining high morale and high operating efficiency had always been difficult in routine military operations, particularly those which seemed to have little of a crisis nature in their character. One of the real reasons for a public information office was to make troops doing mundane duty think of themselves as important and their tasks as glamorous. Until the 417 bird went into orbit, however, there had been nothing routine or repetitive about space operations--except perhaps repetition of crisis. True, many satellites had been orbited, and the recurrence of launch and recovery operations seemed a similar problem. But even if they had outward likenesses, one launch and recovery differed from another, and the physical differences stimulated participants. As much could not be said for a satellite operation routine that within 30 days of its start had become about as exciting as taking a daily barometer reading. It was scarcely a new problem, even if new to space operations. The remedy was classical: inspection, incentives, re-training, and all the time-tested means of "maintaining an alert, competent operating force. . . ."[28] If such problems troubled a research and development operation, how much more would they prove a source of difficulty to an operational unit which would be charged with them not for a few weeks, but for many months, perhaps years. The spectre of uniformed boredom that earlier seers had dubbed the Silo Sitter of the Sixties was sidling into Program 417.

Whether foreseen or not, many of the difficulties that invariably beset any developmental system making a transition to operational use were about to descend for the first time on a space system. (Corona was an operational system, of course, so the real distinction was operation of a space system by an operating command.)

Undersecretary Charyk's original instructions to General Greer had specified that a separate readout system manned by uniformed Air Force personnel was to be in operation by about 1 July 1963, operated by SAC and the Third Weather Wing of the Air Weather Service, but he explicitly ordered that there were to be no elaborate requirements for complete standardization, comprehensive training manuals, and all the paraphernalia so beloved by the Logistics Command. In this respect he was in a position to be more immediately effective than a predecessor who had faced, recognized, and finally won over the same general problem. Years earlier, Colonel W. G. King, now heading one of

General Greer's major program offices, had been in charge of the Snark missile program. When King took it over, the Snark was admittedly in its declining days; roughly six years behind schedule, and widely conceded to have little more than nuisance value. Snark had nonetheless been pushed determinedly through the development process, complying with all the multitudinous requirements of the era. King's job, it developed, was to get the one wing of Snarks ready for placement on their sole base, in Maine. That task he performed most skillfully and with as little damage to the national exchequer as the times would permit. In his efforts to reduce extraneous Snark effort he came across a requirement that operating manuals for new systems be prepared and furnished to all major air bases in the United States. For months King pointed out that Snark, a one-way missile with a somewhat irresponsible guidance system, was not an aircraft and not subject to established rules, was unlikely to settle down at Tinker AFB for emergency repairs, and that in any event it would be rather uneconomical to train repair crews across the country when only 30 Snarks were ever to be available. King concluded, reasonably, that launch crews might well need manuals, but that these could be inexpensively prepared in about 50 copies; mass printing and distribution, he concluded, was not entirely warranted. Convincing necessary elements of the Air Force and securing a waiver on that particular phase of Snark development took Colonel King many, many months.[29]

The distinction between the 417 program and conventional aircraft systems was obvious; differences from established missile programs were less obvious but could be identified by intelligent observation. On the other hand, the 417 program also differed radically in its objectives and techniques from the "pure science" projects of NASA. Program 417 personnel recognized the useful distinctions; because of the tight security bracket around program activities, it often was difficult to communicate the full meaning of the situation to outsiders. The 417 program had been specifically exempted from virtually all routine reporting requirements, and in Dr. Charyk's latest ruling had been empowered to create highly unorthodox operational environments for an operating command to man, but which would never be "turned over" in the traditional sense. The existence of firm requirements for meeting schedules, and for staying within cost boundaries, set the 417 program well apart from most NASA enterprises at the other end of the spectrum. In order to maintain its established high level of program success, the 417 program office would have to perform more skillfully than most others in comparable situations. Charyk's injunction that the program office could purchase boosters through NASA but would maintain Air Force quality control standards, fixed price agreements, and set delivery dates, for instance, added new difficulties to the existing NASA perplex.

By late November 1962, RCA was at work on the second batch of satellites (the follow-on vehicles), a contract covering seven additional MG-18 motors had been let to Lockheed (the motor case had finally failed--at 350 percent of design load!), and the first five Strategic Air Command officers slated to work with the original 417 program office crew had arrived. Additionally, program officers had begun an attempt to obtain Algol IIA motors for Scout first stage use in lieu of the Algol ID motors originally provided. (The IIA promised to be better in thrust and generally more reliable.) Unhappily, few IIA's were available, and most organizations with on-hand or on-the-way IIA's were quite aware of their virtues--as well as of Algol ID disabilities. The 417 office had notably little luck in horse trading--but kept trying. In December 1962, Lieutenant Colonel E. J. Istvan, in the Pentagon office, briefly thought he had talked the Office of Aeronautical Research into a swap, but that organization reneged when the thrust advantages of the Algol IIA were defined. Navy's Bureau of Weapons would not even consider a trade. Program 417, it seemed, was to continue with the Algol ID regardless of desires.[30] For the 417 payload, the thrust differential would be measured in orbital altitudes: about 500 nautical miles for the Algol IIA against 375 miles for the Algol ID.[31]

With the potential of the 417 satellite thoroughly proven, it was becoming increasingly clear that the greatest danger to continued program success lay in the ineffectiveness of the Scout booster. On 6 December 1962, the program office began a study of alternatives. The field was initially limited to the Thor-Delta (Thor with a Vanguard upper stage) but later expanded to include Thor-AbleStar (Thor with an Aerobee upper stage) and Thor-Agena (the combination used in Program 162, still known as Discoverer). General Greer had no doubts about the importance of the program, then and for the future. With the Cuban operation in mind, he wrote one of the test wing commanders that, "The output from Program 417 has contributed significantly to the success of recent operations of the greatest national importance. Each successful readout results in strengthening our military capability."[32]

The Eglin operation actually stopped a week after General Greer made that analysis--the Cuban crisis having simmered down--and a dispassionate evaluation of results began. (The readout station remained in storage, ready for reactivation on 24-hour notice.) There was the confusing if interesting revelation, for instance, that readout had somehow been better at low than maximum elevations. Similarly, it was becoming obvious that the problem of operator error arising from simple boredom might be greater than anyone had foreseen--a conclusion drawn from the first five months of experience with operators at New Boston. The familiarity-breeds-contempt syndrome had taken new turn.[33]

More commonplace problems, some in new colors, also reappeared. NASA, it developed, was not prepared to quote a precise dollar figure for Scouts, and SAC had no sooner acquired an interest in the satellite than that command began insisting on acceptance of its own notions concerning control centers and the like. But in the circumstances, these still were irritants more than obstacles. Colonel Haig, who had been with the program almost precisely sixteen months, chose early January 1963 to propose an expanded program and to review for Dr. Charyk the past and future of the 417 program.

The great talking point still was the first satellite, vehicle 3502, which after 137 days and 1968 orbits (as of 7 January 1963) was returning better cloud cover information than immediately after its launch. That peculiarity Colonel Haig ascribed to improvement in operator techniques which exploited the full potential of horizon sensor efficiency and readout effectiveness.

The selection of a contractor to construct and activate two readout stations for SAC had by then been made. The 417 office had let the contract at a fixed price of [redacted] with a completion deadline of six months. Experienced research and development officers in SSD had sternly cautioned Haig and General Greer that the work would cost at least three times that much and take three times as long. Colonel Haig, who had made the original estimates and stood by them, had convinced Greer he could get the work done in the time and at the cost quoted.[34] Radiation Incorporated had won the contract and was hard at work preparing two stations, two 40-foot radar dishes, radomes (the dishes were too fragile for strong winds), and equipment vans. Haig had located two abandoned Nike missile sites, one in the Northeast and the other in the Northwest sections of the United States, had acquired them at no cost to the program, had seen to it that full advantage was taken of existing roads and buildings, and was fully confident that the contractor would do as he had promised, and in the time allowed.

In Colonel Haig's judgment, the demand for the 417 system was more pressing in early 1963 than at any time in the past. Continual slippage in Nimbus schedules and major technical difficulties in its development tended to make 417 increasingly attractive. The pointing accuracy of Nimbus promised to be in a six-degree cone, at best, the prototype was seriously overweight, the power source--solar panels--was in serious trouble, the launch schedule had slipped by nearly a year in an elapsed six months, and there was no real possibility of constructing something to do the same task as Nimbus, such as an "operational" Tiros.

SAC's interest in the 417 satellite had increased considerably after exposure to early results. The 417 represented a near perfect training device for space operations, being stable, dependable, and relatively uncomplicated. Operation by a field command was not particularly dangerous for the vehicle on orbit. (Haig called the 417 satellite "idiot proof.") Perhaps most important, the system was inexpensive to operate and maintain. Finally, there was increasing pressure from the Navy and the Strike Command for a tactical readout system; the Air Force had a small but significant investment in ground stations--and one that would not become rapidly obsolete, either--which underlined the importance of continuing an active space program; and there was a substantial opportunity for inexpensive experimentation. Taken together, these represented solid arguments for continuing, indeed for expanding, 417. So long as it retained its basic characteristics of simplicity, reliability, and economy of operation, it remained attractive.

Colonel Haig seemed convinced, even this early, that the eventual salvation for 417 lay in adoption of a new booster. The studies begun the previous month had identified the Block II Thor (with Bell Telephone Laboratories guidance) and the Agena D as the most economical booster combination. The two provided the greatest injection accuracy, highest theoretical reliability, and heaviest payload potential of all the systems examined. Haig contended that a Thor-boosted 417 could be a heavier satellite, one capable of covering the entire northern hemisphere and having an average orbital life expectancy of eight months. Such a vehicle could easily incorporate a tactical readout capability, could grow to 700 pounds payload, could include three remote cameras and three backup cameras (one for each primary), and could operate on a 60-kilocycle bandwidth with one-half-mile resolution. The program office estimated that [redacted] would buy and launch six such satellites.

In support of an "advanced 417," Colonel Haig's office proposed two specific developments: a stabilite--a miniature stable platform and associated circuitry--and a new ion detector attitude sensor. He asked Charyk to authorize expenditure of [redacted] for the stabilite and [redacted] for the detector.

Charyk approved the additional funds but withheld any ruling on the need for a new booster.[35] For the rest, Haig and his group had to prepare more detailed proposals. The stabilite--which had actually been conceived in the course of a technical discussion between personnel of the 417 office and RCA representatives--embodied the notion of torqueing the main body of a spacecraft about a flywheel that was spun up by rockets. The concept promised a useful compromise between the stable platform that was so desirable from the standpoint of photography and the spin-stabilized body which offered so much in simplicity of stabilization technique.[36]

In mid-February there was an interesting meeting in Washington with implications for the far future of the entire 417 effort. The gathering included Charyk and Dr. John Ruebel of Directorate of Defense Research and Engineering, Dr. S. Fred Singer of the Weather Bureau (he was the originator of the MOUSE satellite proposal of 1953 which so profoundly influenced the IGY program), plus two representatives (named Hoffman and Eaton) from the Department of Commerce. Nobody from NASA was on hand; Haig was there. The crux of the meeting was Ruebel's blunt statement that he wanted to get Nimbus responsibility transferred from NASA to the Air Force, after which the Air Force would support Weather Bureau satellite objectives. The Department of Commerce was in favor. Singer's reaction was not noted, but could be guessed: the Weather Bureau wanted an operating system. Ruebel, whose fiscal and engineering conservatism had given him the general reputation of automatically opposing all new proposals for space systems, said frankly he favored expanding Program 417, wanted the 417 team held together, and expected to issue instructions authorizing a low-classification 417 program in support of Weather Bureau objectives.[37]

Such an attitude had far reaching implications. That SAC would have effective control of satellites in orbit was assured, and that a more elaborate satellite system would be developed for military use seemed probable. That Nimbus shortcomings were becoming ever more apparent and that technical faults promised to delay its availability further complicated the situation. Nimbus seemed destined to become an "international" weather satellite in concert with the still-honored space-for-peace theme. It could never completely satisfy Air Force needs, even if a resounding success, since as designed it would provide insufficient north latitude coverage.

Haig's people had reservations on other accounts, too. Reasonably familiar with the technical details of Nimbus, they were convinced that it had inherent technical failings, particularly in the power supply system. Finally, Nimbus was dependent on a new concept of stabilization that had never been test flown. All in all, Nimbus seemed quite unlikely to serve Air Force objectives. (The fact that it would rely on an electrostatic tape system of undetermined reliability did little to endear Nimbus to Air Force people who had recent sad experience in tests of similar systems for a proposed Samos E-3 application.[38]

For the moment, however, there were other problems of more immediate concern. On 19 February the second 417 satellite went into orbit. It was not placed as accurately as the first, being 50 miles low in apogee and 140 in perigee, as well as having a two-degree inclination error.[39] Initially it appeared that the fault lay in a fourth stage separation which occurred at too great an altitude and too low a speed. Further analysis indicated that each of the first three stages had performed badly--although the ABL X-259 third-stage engine was the chief offender. In any event, the satellite was in a "less than optimum" orbit.[40] Its functioning was generally acceptable, even under such handicaps, until late April, when the primary tape control circuit went bad, eliminating the bird's ability to store primary data. The direct readout mode remained operational and 80 percent effective. By September 1963, however, the satellite would have gotten so thoroughly out of phase with the sun that a 180-degree reorientation would be necessary.[41]

The February 1963 launch (Operation 0240) proved the feasibility of still another innovation in cloud-cover reconnaissance. Nearly a year earlier, the program office had undertaken a study of radiation measuring subsystems, devices which by registering background radiation from the earth's surface could identify night cloud cover. The small investigation had been stimulated by General Greer's observation, in March 1962, that it was unfortunate that a cheap infrared system was not feasible.

In the course of their inquiry, program office people discovered that Dr. V. E. Suomi of the University of Wisconsin had produced a prototype and one flight-model infrared sensor for the Explorer program. Because of changes in that NASA activity, the sensor had never been orbited. It had every indication of meeting the requirements for a secondary payload for the 417 spacecraft.

On 3 September 1962, the program office let a low-cost contract covering rehabilitation of Suomi's prototype and tentatively scheduled it to be flown on the fourth 417 satellite (0240). By December 1962, test results were so promising that contracts were let covering the design, development, and test of five additional subsystems (one prototype and four flight versions) for use with the second group of four 417 spacecraft, then on order.

All went well and the first Suomi radiation measuring subsystem was aboard 0240 for its February 1963 launch. The device functioned perfectly; by May 1963 infrared data were being routinely extracted and the system still was 95 percent operational. It continued to function until January 1964.

From the data obtained through the Suomi system, the Third Weather Wing, using computer programs written entirely by Air Weather Service personnel, produced daily operational maps of night-time cloud cover throughout the entire period from October 1963 through January 1964--the span of the Cuban crisis and the immediate aftermath. The technique was so successful that extension of the infrared measurement program was subsequently approved and it acquired the role of a semi-permanent element in the total 417 system.

Reaffirmation of the reliability and operational potential of the 417 satellite was provided by the second insertion into orbit. The dubious reliability of the booster was again underscored. Essentially, of course, both such facts had been generally appreciated earlier. The results of the February 1963 "success," therefore, tended to accelerate consideration of an enlarged program, one embodying a more sophisticated set of sensors and based on a considerably more trustworthy booster. The general notion, by early March 1963, was that use of Thor-Agena as a booster would provide enough additional lifting capacity to permit launching a new satellite based generally on 417 technology but also incorporating the best proven features of Tiros, Nimbus, Relay, and other satellites into a system with minimum requirements for a long and costly development process. The general proposal, known as 417-I, had all the operational potential of Nimbus plus circuit redundancy which promised enhanced reliability.[42]

The proposal to develop 417-I also had attractions other than technical. General B. A. Schriever, Air Force Systems Command chief, heard the 417-I presentation on 15 March, indicated that he was "intensely interested," and asked that he be provided with a formal development plan at once. He agreed that the program should remain in the SAFSP management family, but he suggested that the existing secrecy restrictions would have to be relaxed to "resolve the management problem with NASA and the Weather Bureau." Colonel Haig mildly observed that a program operated through two parallel management channels was "probably impossible and certainly undesirable," an opinion in which General Greer concurred.

The appearance of two viewpoints on how 417-I should be conducted reopened all the past arguments about the need for a secure system for military weather reconnaissance. Nevertheless, there were sound indications that Ruebel of DDR&E seriously planned to substitute 417-I for Nimbus. The problem was how.[43]

In the meantime, while involved questions of national policy toward weather reconnaissance were thrashed out in Washington, the

417 office had the more immediate problem of carrying out its original assignment. Initially, the program had contemplated a prototype and four flight satellites, plus ground equipment and spares. In November 1962, after the passage of the Cuban crisis, a new contract had been written with RCA to cover modification (upgrading) of the prototype, four additional flight satellites, and the usual ground equipment and spares. In May 1963, while a decision on a weather reconnaissance system to follow the original 417 still was pending, Colonel Haig secured Dr. Charyk's endorsement of a program extension involving six more satellites in the original configuration plus the Scout boosters, spares, and ground equipment needed to continue the program from December 1963 through September 1964. (The contract with RCA was signed in June. The total of dollar investment with RCA reached [redacted] for the basic flight program plus [redacted] for a prototype and two flight model stabilites.)

Charyk was thinking less in terms of a substitute for Nimbus than of a basic 417, improved, modernized, and mated to an improved Scout booster. The details of 417-I were far from certain, Charyk having expressed marked reservations about the cost of using Thor-Agena, the redundancy of a stabilized Agena, and the prospectively high command and control costs if Agena were employed.[44]

Permeating all such proposals and discussions after early 1963 was a general conviction that something radically effective would have to be done to improve the Scout vehicle and to enhance NASA's appreciation of 417's real importance. The dissension which had been apparent virtually from the time the program began, certainly from the date at which Colonel Haig proposed substituting the MG-18 for NASA's upper stage, lessened not at all in the early months of 1963. NASA persisted in efforts to extend its virtually complete control of the boost vehicle program effort, even insisting at one point on being reimbursed for "travel in support of 417 vehicles procured partly through NASA." The Air Force Scout office--which sometimes had the bedraggled appearance of a bewildered canary that unwittingly flew into a badminton court--asked the 417 program office to pay the bill. Indignantly, Lieutenant Colonel J. R. Smith, Haig's deputy, responded that "at no time has this office requested any support from NASA." Furthermore, said Smith, "all 417 vehicles procured until this time have been contracted for directly, and contrary to the desires of several persons in the NASA, we have endeavored to . . . remain independent of any NASA support." (NASA, apparently not at all embarrassed, subsequently explained that there had seemed no need to document requests for assistance originating in the Scout office and the 6595th test wing--

and then in the best tradition of one-upmanship added, "In the event SSD is unable to pay for the support previously given, NASA will not press this point to any extreme." The sum involved was [redacted]

The real source of difficulty lay closer. On 19 April, in response to a 417 office query, the Scout office conceded that the X-259 third stage, which had performed so inadequately in the February launch, had a dubious performance potential. But the Scout people were quick with assurances that the motor going into the next scheduled launch vehicle was flight-worthy. Precisely one week later, on 26 April, the fourth attempt to orbit a 417 satellite ended in loss of third-stage thrust eight seconds before scheduled burnout, followed by violent tumbling and total destruction of the upper stage and payload.

The failure was bad enough in its own right. But subsequently the program office discovered that the third-stage motor which had caused the failure was one which had been earlier rejected because it had been dropped during shipment. NASA had inspected the rocket stage on its return to the factory, had declared it flight-ready, and had approved its use on another 417 booster. But nobody had told the 417 office of the motor's earlier history.[46]

The matter of determining what part mishandling had played in the failure of the fourth 417 vehicle became less urgent when detailed analysis indicated that inadvertent actuation of the third-stage destruct mechanism was the prime culprit. Through the Space Systems Division, the 417 office asked for a special effort to insure that destruct mechanism would not be activated accidentally in future launches. NASA brushed aside the query, issuing a new proclamation of confidence in the existing Scout.[47]

The 417 group was less than satisfied. Late in May Colonel Haig induced the Scout directorate to ask the commander of the Pacific Missile Range to have the command destruct transmitter continue to illuminate the vehicle with "the strongest possible carrier signal" until fourth-stage operation had been confirmed. That precaution would guard against the possibility that the destruct mechanism might respond to some random signal once the illumination was cancelled.

Additional requests for improvement of the destruct mechanisms went to NASA, but with an admitted expectation that the space agency would refuse to take effective action. NASA spokesmen in early June took the position that if the Air Force insisted on modifying the destruct plugs on Scout vehicles the change would be arbitrarily rejected for NASA-launched Scouts.

Captain R. L. Geer, an outspoken member of Colonel Haig's 417 group, discovered at about the same time that the command destruct receiver in the Scout third stage was extremely susceptible to random noise activation--Geer told Colonel Haig that recent tests had proved not only that the receiver would react to random noise, but that "it was particularly susceptible to Rock and Roll stations. Especially when male 'singers' sounded the letter 'P'." A possible sequence of events, then, would have the ground station transmitters shut down their destruct circuitry illumination once the Scout was safely out of the launch base danger zone, at which point an opportunely timed rock and roll recording broadcast from Santa Monica could touch off the destruct charge.[48]

By early May 1963, the generally unsatisfactory characteristics of the Scout booster had received widespread recognition. Quite apart from the impulse to go to a more powerful booster as a means of putting a heavier and more sophisticated payload in orbit, there was a general determination that either Scout would be significantly improved or the Air Force would go to a more reliable vehicle.[49] And so slight had been NASA's response to pressure for improvement of critical Scout features that some members of the program office had become quite outspoken in their criticism, not only of NASA, but also of the Pacific Missile Range. The obvious course of having the Air Force sponsor its own improvement program was politically inexpedient, so the 417 office was reduced to the expedient of proposing actions which seemed essential but of being unable to secure their adoption. Even when logic and common sense were translated into directives carrying the signature of the Air Force undersecretary, they had no apparent effect.[50]

In part, the concern for Scout unreliability was an expression of program office resentment at having been unable to put a new 417 satellite into orbit at a time when the two earlier vehicles were running down. On 11 June, after nearly 10 months of circling the earth, the original 417 satellite (vehicle 3502) responded to ground commands for the last time. Attempts to recapture control by reorienting the bird were unsuccessful later that month, forcing the ground controllers to postpone further efforts until the satellite assumed a more receptive attitude as a result of its gradual change of position in orbit. Concurrently, the program office suspended operations involving the second satellite (vehicle 0240) for intervals of two or three days at a time--and by that time 0240 was functioning only in the direct readout mode.[51]

Apprehension that unprogrammed actions by the 417 satellites might be the consequence of skillful Soviet interference had generally subsided by June 1963. After the original flurry of suspicion had stilled the previous fall, there had been a recurrence in February and

March 1963. Examination of tapes of command and response signals caued the program office to alert Vandenberg early in March and, somewhat later, to examine the possibility of incorporating communication safeguards--receiver clocks or multi-tone signals, for instance.

Later analysis indicated that the two satellites had been subject to "unintentional or at most unintelligent jamming."[52] In some respects, that fact continued to surprise program office people. Command channels, and most signals for that matter, were near identical to those used for Tiros. They were not classified and Soviet sources certainly had full knowledge of their characteristics. By the same token, the orbits of the 417 satellites were readily determinable. Random sampling by one or more of the abundant antenna-encrusted Soviet "fishing trawlers" could have confirmed the general features of the signals, and either jamming or transmitting spurious commands would thereafter have been a simple matter.[53]

Almost unnoticed in the mounting clamor against NASA's handling of the Scout problem, the Strategic Air Command on 12 July 1963 began operating the first two military readout stations, one at Fairchild AFB, Washington, one at Loring AFB, Maine. RCA manning of the now-discontinued New Hampshire station and ground support for satellites in orbit halted simultaneously. Initially, the two operational stations would handle only satellite 0240, although there still remained hope that 3502 might be made to respond to commands at a later date. Since neither satellite was fully capable of normal operation, SAC could not exercise all systems, but it was a start. Data analysis began at Offutt AFB (Omaha) simultaneously.

The SAC personnel who had worked so wholeheartedly in the 417 office for the previous six months were mostly gone. (A side effect of station activation was a minor manpower crisis in the program office, where Colonel Haig had used "trainees" to keep the program moving, even though most were completely unsophisticated about space when they arrived.) Much remained to be done; in anticipation of SAC operator requirements, the program office had set out to prepare detailed written procedures for dealing with every possible contingency in satellite operation--and they were ready in time for the 1 July site activation date. Nevertheless, the transition from contractor to SAC operation of the readout stations marked a major turning point in the evolution of an Air Force space capability. Unfortunately for the legend that a public relations staff had to tout all aspects of the shift, but to the considerable advantage of program security, the entire transition was handled with a discretion and uncommunicativeness that had come to characterize all 417 activities. The major milestone, the first operational Air Force space system, went unheralded.[54]

Subsequent to transfer of the readout stations, there was some consideration of allocating a Scout launch facility and total launch responsibility for 417 to SAC. The strategic command was definitely interested, but only on condition that the launch vehicle be standardized and that routine logistic support be provided through Air Force channels. There lay the difficulty, for NASA was if anything more reluctant than before to give the Air Force any significant control over Scout development and fabrication, and was equally insistent on keeping control of resupply. There was one other objection: SAC, lacking trained and experienced launch personnel, could scarcely be expected to better the launch record of the expert technicians who, so far, had managed only 50 percent successes. In that respect, prospects for early transfer of total 417 launch responsibility to SAC seemed dim.[55]

Through the long summer of 1963 the controversy with NASA--it could not honestly be called by another name--grew more heated. In part it was fanned by persistent difficulties in attempts to get another satellite into orbit. The booster was to be Scout 132. A two-month delay extending from 29 July 1963 through 27 September had developed because of faulty trajectory computations, revision of the upper stage destruct system, discrepancies in the electrical connections to and within the launch vehicle, major problems with the new first-stage booster (Algol IIA), and a host of miscellaneous items.

The original request to NASA asking a change in the physical features of the destruct system's electrical connections had provoked a prompt and strong "No." SSD formally asked "please" a week later and got a "Hell no" reply by telephone. (NASA insisted that modifications would delay delivery and force a launch postponement.) Not for another six weeks was there a change, and then it came because of pressure from the Secretary of the Air Force.[56]

Scout 132, scheduled to boost the fifth 417 satellite, had originally been delayed in launch because of concern arising from the failure of a NASA Scout (110) late in July. Engineers had determined almost immediately that the nozzles of the Algol IIA first-stage rocket had caused the difficulty. Test stand trials disclosed both design and fabrication defects, forcing suspension of all Scout operations. Use of the original Algol ID first stage had been scheduled to end in June. Colonel Haig personally wrote the chairman of the board of Aerojet General, the Algol IIA fabricator, to ask for emergency speed in correcting defects. An Aerojet respondent retreated to phrases like "unparalleled reliability" in describing the stage and ascribed the failure of 110 to a change of techniques at a subcontractor's establishment.

That bland and misleading generalization caused even General Greer, normally quite restrained, to make impolite remarks on the lines of ". . . we found we were skating on the thin edge of disaster every time we lighted one of those things."[57]

Whatever Aerojet General's opinion, SAFSP preferred to rely on test results, and once these were available went immediately back to the Algol ID motor. The lesser thrust of the Algol ID as against the Algol IIA forced adoption of a more powerful X-258 fourth stage. The only one available was at Arnold Engineering Development Center for burn tests; the 417 office had it sent immediately to Allegheny Ballistic Laboratories (the fabricator) for flight readiness tests. Resort to the X-258 in turn forced a change in the spin-up rockets, an unorthodox arrangement of one long-burn and three short-burn devices which Chance-Vought initially rejected out of hand and ultimately had to be coaxed into adopting.

The Air Force, which for months had been seeking means of improving the Scout's reliability, discovered in August that NASA had not scheduled either ultrasonic or X-ray tests of Algol IIA nozzles. NASA had refused to apply quality control standards to them. Captain Geer, who looked into the situation, reported dispiritedly that NASA was quite content to have the Air Force fly "development" Scout boosters since ". . . we are doing as much to supply them with development data on their vehicle as . . . putting our payload into orbit."[58]

By July 1963, NASA had experienced its first two "operational" Scout failures; until that time one of the standard NASA gambits had been to explain the 417 launch problems in terms of general Air Force incompetence. (NASA never entirely gave up that approach, its own problems notwithstanding.) The Air Force viewpoint was that inadequate quality control and slippy configuration control were basically at fault. In the case of Scout 132, the Air Force seemed to have the better of the argument. Before it finally reached the launch stand, Chance-Vought was obliged to rework more than 132 individual solder connections--a clear indication of qualitative inadequacies. In the same period the Air Force had vast difficulty in getting correct trajectory computations from Chance-Vought. Component weights were not always entered in the totals, there were errors in compiling subsystem weights, and the contractor seemed immune to suggestions that the program was rather urgent.

In the matter of configuration changes, NASA continued its bland course of altering components without much concern for the effect of the change on Air Force launch procedures. The beacon in

132 was modified, for instance, so that it was incompatible both with the Pacific Missile Range frequency assignment and with the Scout antenna system. Antenna changes which thus became mandatory contributed to the launch date slippage.

An even more significant fault in 132 became apparent when the interstage between the first and second stages--the B section--could not be mated to the castor nozzle of the second stage. Cursory examination disclosed that the shear pins in the B section were longer than and misaligned with the reception holes in the castor nozzle. A total of five different B sections were tried with five castor motors in all possible combinations and none would fit. The jigs were incompatible. Such a basic error was incomprehensible to program office people. By all indications, each hole had been drilled by reference to some other hole rather than from a standard reference point.[59]

Even before vehicle 132 became something of a cause celebre, General Greer had induced Air Force Undersecretary Brockway McMillan to write NASA's Associate Administrator, R. C. Seamans, concerning Scout defects and Air Force judgments on their cause. McMillan, still hopeful that the Scout might be upgraded and made an acceptable launch vehicle, told Seamans that a decision on the continued Air Force use of Scout was pending, that its current reliability was too low to make its use attractive, but that on the whole there were obvious benefits to improving Scout reliability instead of going to another booster. To prove his point, he attached a list of "selected management problems." Several among those cited had earlier been called to NASA's attention. Others were relatively new.*

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* Included in McMillan's summary were these entries:

In late 1962 NASA made major modifications of the jet vane design without notifying the Air Force. That service learned upon unpacking vehicle 216. The modifications had never been flight tested before being incorporated in that booster (a 417 vehicle). Said McMillan: "417 was faced with accepting the honor of flying first" or indefinite delay.

NASA had completely ignored three requests for clarification of invalid spin-up data.

No Scout body bending mode investigation had ever been conducted: NASA treated Scout as a rigid body insofar as control system dynamics were concerned--though that seemed a somewhat shortsighted outlook in light of the Scout's four-unit configuration.

NASA insisted on subjecting 417 vehicles to special electronic circuitry tests that both the contractor and the local plant representative (Navy) considered entirely unnecessary, even harmful.

NASA had refused to change pin assignments to reroute current away from the destruct mechanism so as to insure against short circuits.

NASA had originally quoted fourth-stage motors at $14,000 each. In August 1962 the agency had indicated a January availability at $20,000. After encountering major technical difficulties and indulging in several contract overruns, NASA was then (June 1963) quoting $30,000 and still had not delivered.

Seamans replied on 15 July (after the certainty of a slip in the scheduled launch of 132 had become common knowledge) that the Scout had "satisfactory reliability" and an "acceptable record." He cited an 80-percent success rate in Wallops Island launches by NASA crews. (To get the 80-percent figure Seamans had ignored three failures in the first eight "development" launches and had considered only the four successes in five "operational" launches.) Seamans also drew an unflattering comparison between the Wallops Island record and that at Point Arguello, on the Pacific coast. He observed kindly that the Pacific Missile Range launch crew had been formed "late," thus contributing to the failure of four launches in eight tries. He also suggested that the modifications of Scout to

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NASA had rejected flight-ready motors on their arrival at the Pacific Missile Range because of the absence of NASA criteria, though they fully satisfied Air Force needs.

Although the Air Force had singled out the need, NASA had never conducted torsion or bending tests on the Scout transporter.

NASA plans for changing the Point Arguello launch facility had been drawn in December 1962, but the Air Force had not been notified until 12 February 1963, with the result that the line of sight from the on-pad payload to the payload van had been interrupted. No correction had been made by June.

conform to 417 requirements and related departures from NASA "specifications and procedures" were the true culprits. He concluded by opposing any change to the existent management structure, the NASA/DoD Scout Coordinating Committee arrangement which, he argued, was functioning effectively.

Colonel Haig's commentary on the Seamans' letter confined itself to detailed refutation, but it bristled with unspoken indignation.[60] By that time, however, he was more gravely concerned with the immediate problem of shaping Scout 132 into a vehicle which could actually be used to launch the fifth 417 satellite. He summed up a situation which had grown steadily more difficult in the months since 132 had first encountered problems in meeting schedules and performance requirements: "The SLV-I launch team, having intimate knowledge of all the new and different features incorporated into the booster for operation 1610, have begun to call it the 'X-132.' Their point is well made . . . ."[61]

Since the Air Force still hoped to convert the Scout into a standard launch vehicle suitable for assignment to operational squadrons, the continuation of such a situation was intolerable. In June 1963, Colonel Haig had outlined a set of conditions which he felt would tend to improve the reliability of the Scout. In August, the SSD Scout directorate proposed them formally to NASA. They were given some apparent force by being coupled to the pending procurement of six more Scout boosters, but in fact no conditions could be imposed because of the earlier (June 1962) agreement which gave final authority to NASA in virtually all Scout matters. The space agency responded to a threat not to use the X258 fourth stage by saying that it had been proven flight worthy. NASA also refused to agree that the Air Force should have a veto on proposed vehicle modifications.

The Scout office was wearily inclined to accept NASA's position on modifications, hoping that the Air Force would be consulted on any action which would "drastically affect" the Scout's ability to perform the 417 assignment. Colonel Haig was markedly less conciliatory, appreciating from sad experience that he had to have some control over modifications which would change vehicle performance or reliability and not at all certain that NASA would concede so elementary a courtesy.[62]

His misgivings were confirmed less than two weeks later, when he learned that the X-258 fourth-stage rocket was due for an additional change which would reduce its payload potential to the point of being but four pounds greater than the MG-18. It developed almost immediately that Haig's information was only partly correct. In actuality, NASA had totally changed the basic configuration of the X-258 to make it compatible with the NASA version of Thor. By virtue of an increased aft diameter, the X-258 would no longer be adaptable to the 417 configuration. The structural integrity of the X-258's case was weakened in the process. The Air Force Scout office promised Haig that all Air Force purchases would be in the former configuration, that if NASA refused to cooperate the Air Force would buy directly from Allegheny Ballistics Laboratory.[63]

In light of the complete lack of success in obtaining like concessions from NASA in the past, Haig seemed justified in any reservations he might entertain. As it happened, the issue rapidly became inconsequential. On 27 September 1963 the fifth 417 launch was attempted; it ended in the third booster failure. The precise cause was somewhat obscure; failure occurred because of a malfunction of the third-stage control system arising from a premature loss of hydrogen peroxide. The immediate consequence was an explosive failure near the pitch-down jets of the third stage.[64]

On 3 October, four days after the launch disaster, Colonel Haig briefed Undersecretary McMillan on the launch and on program status. McMillan seemed to favor a booster other than Scout.

Going to Andrews Air Force Base from his Pentagon stop, Colonel Haig found himself in conversation with Colonel Rodney Nudenberg, a key member of General Schriever's Air Force Systems Command Staff. Nudenberg passed along instructions from General

Schriever to Haig: the 417 director was to begin an immediate study of Minuteman and Thor as alternates to Scout. Haig told Colonel Nudenberg he had received earlier instructions along those lines from Undersecretary McMillan and had completed considerable work before coming to Washington. (The study had begun almost precisely 10 months earlier and preliminary results had been in the undersecretary's hands for at least eight months!)[65]

Haig apparently did not pass to Nudenberg the remainder of McMillan's instructions--that he was to continue with plans for at least one more Scout-boosted program launch, to complete study and planning for a single trial launch using the Thor-Agena combination, and to complete the study of Minuteman potential. McMillan had been rather specific in another direction; Haig had orders to work out an estimate of the money that could be recovered by a complete cancellation of Scout procurement.[66]

And the prospect of continuing with Scouts in their current configuration apparently was closed. On 7 October, acting on instructions from Colonel Haig, the Scout directorate at SSD formally cancelled the last two vehicles on the original delivery order and all six of the follow-on order. A stop work order was issued to cover all vehicles subsequent to number 134--later extended to include 134.[67]

McMillan had authorized Haig to participate in a scheduled Scout reliability improvement meeting, set for 14 October, in a last desperate attempt to convince NASA that the alternative to meaningful action was cancellation. Nothing useful resulted. On 21 October, Haig again reported on program status to the undersecretary. Three days later, on 23 October 1963, McMillan ordered immediate cancellation of all activities connected with the Scout booster, immediate effort to recover every possible dollar from NASA, and assignment of a Thor-Agena from "available resources" to support a December or January 417 launch. The launch was to be in a dual payload configuration originally described by Haig during his 3 October presentation. Development of the "optimum" payload capability was also authorized in the undersecretary's 23 October instructions.[68]

"Complete and immediate" termination orders went to NASA early on 25 October 1963. The instructions were impossible of misconstruction: everything connecting 417 to Scout was to stop except the final report on the disastrous 132 launch.[69]

Thus ended the Scout phase of Program 417. In five attempts, the program office had one unqualified success, one partial success, and three catastrophic launch failures. After-the-fact investigation had clearly identified major booster faults in each of the "successful" launches; with a fractional difference in luck, the booster might well have contributed to five successive failures. The satellites had operated marvelously well, considering their difficulties in launch phases.

To its credit in the Scout phase, the program had also the record of the first successful use of a space vehicle in actual combat troop operations (the Cuban crisis of October 1962), the first ground control stations to be built for an operational command's use in space operations, and the first transfer of total space vehicle operational responsibility to an operational command. The program office had a remarkable record of cost effectiveness, had functioned with a combination of fewer inhabitants and larger responsibilities than any other space vehicle development in Air Force history, and had progressed from concept to satellite in orbit more rapidly than any earlier organization. A host of technical achievements, some with implications of tremendous value for the future, had to be added to the scorecard.

Epilogue

The termination of Scout usage did not in any respect cause a break in the frantic pace of program office activity. On 5 October, the Saturday following his presentation to McMillan, Haig asked the SSD Deputy for Boosters, Colonel R. W. Hoffman, to aid in a special study of Minuteman as a 417 booster. He told Hoffman he needed to put 150 pounds in a 500-mile orbit at 96 degrees of inclination and asked for any additional payload lift capacity that could be identified. On the following Tuesday the program office began working on the 417 Mod 2 program--the Thor-Agena dual-payload launch proposal Undersecretary McMillan had initially approved. Still very much in contention was the stabilite development begun much earlier, a program which, if successful, would provide a constant rotation rate and vastly improve attitude stabilization for later 417 (and other) satellites.[70]

At the time of the Scout cancellation, the 417 office had completed or had in being payload and related contracts totaling [redacted] exclusive of boosters. The primary mission of the program was as before: to maintain a satellite system in operation at all times to provide accurate cloud cover information over various areas. A corollary responsibility was to introduce system improvements where warranted on a cost-effectiveness basis. Bomb damage assessment had become a probable assignment as early as June 1963--at least from the viewpoint of the Strategic Air Command chief, General T. S. Power.[71]

Apart from its general advantages, the 417 had also succeeded in establishing a support relationship between space operations and existing logistic agencies. Sacramento Air Materiel Area, the responsible field organization, proved both cooperative and efficient in obtaining ingredients needed to keep the ground stations operating and, perhaps more important in some crisis situations, proved capable of working out paperwork tangles that otherwise might well have stalled the program. (After the order to shift to Thor-Agena, Colonel Haig was unable to work out a neat and legal means of getting his hands on a bearing to interconnect the 417 payload to Thor. He solved the difficulty by picking up a bearing--literally--while visiting Chance-Vought, telling the people there he would get them paid somehow. He brought it back to Los Angeles as personal baggage, got it to the booster people, and having eliminated a technical roadblock gave the paperwork mess to his procurement people. They solved it. Haig was never certain how, but he was grateful.)

Finally, the 417 operation developed, or displayed, a rare competence in the uniformed Air Force. Not commonly did a program office composed almost entirely of officers have the opportunity and occasion to exercise both managerial and technical talents to the degree of the 417 office. The lack of a systems engineering-technical direction contractor often challenged program officers, but ultimately the lack served to prove that under controlled conditions none was needed. The program operated under security wraps that precluded widespread knowledge of program accomplishments, even within the Air Force, and there was none of the publicity that characterized other programs of the time. Ill effects were nonexistent.

Program 417, as it was known in 1963, was in many respects the antithesis of the "ideal" Air Force development program. It was run on a tight budget--about one-third as large as would have been required in "normal" circumstances. It functioned without reliance on the elaborate complex of contractor technical support common to space and missile programs of the time, and seemed to prosper thereby. It was managed by people who were constantly at odds with other government agencies nominally supporting them, and who took great pleasure in ignoring established review and approval channels. It was marked by a reporting and monitoring system notable chiefly for inconsequence--and for effectiveness. It met budget and schedule goals, and satisfied established program objectives. That it was able to do as much seems to have been very largely the consequence of its having been managed by three extremely capable, strong-minded individuals, Colonel Haig in the program office, General Greer at the directorate level, and Dr. Charyk at the National Reconnaissance Office. In the first decade of the space age, only the early Corona program and the post-1962 [redacted] program, could claim similar records--and both were characterized by the same emphases on program austerity, minimum reporting, avoidance of publicity, direct lines of authority, and program management that verged on the iconoclastic. That was the decade of the B-70, the F-111, the C-5, and the Skybolt--all marked by enormous technological ingenuity, great public acclaim, massive program manning, striking cost overruns, and lengthy program delays (or cancellations). It was surprising that more had not been made of the contrast by the end of the decade.

NOTES ON SOURCES

1. Memo, no signature, by LtCol T. O. Haig, D/Dir/Prog 35, 17 Nov 60, subj: 698BH Chronological Program History, with supplements to cover the period 17 Nov 60 through June 1962, in Prog 417 files.

2. Ltr, MajGen O.J. Ritland, Cmdr SSD, to LtGen B.A. Schriever, Cmdr AFSC, 31 May 61, subj: Development Plans in Support of Five-Year Space Plan, in SSD Hist Div files; P-35 Hist Rpt, Aug 61, in Prog 417 files; History of the Deputy Commander for Aerospace Systems, 1961, prep by DCAS Hist Ofc, Jun 62, in SSD Hist Div files.

3. P-35 Hist Rpt, Aug 61.

4. MFR, Col H.L. Evans, V/Dir, Samos Prog, 19 Jul 61, subj: Meteorological Satellite Program, in Haig files; P-35 Hist Rpt, Aug 61.

5. Memo, J.V. Charyk, SAFUS, to DDR&E, 4 Aug 61, subj: Meteorological Information Satellite, in Haig files; memo, Charyk to DDR&E, 7 Aug 61, same subj, same file; memo, MajGen R.E. Greer, Dir/Samos Prog, to Dir/P-35, 7 Aug 61, subj: Project 35, in Prog 417 files; TWX SAFMS 61-96, Ofc Miss and Space Sys, SAFUS, to SAFSP, 8 Aug 61, in Haig files; P-35 Hist Rpt, Aug 61.

6. TWX NBE 74, NASA (Wash) to SAFSP, 11 Aug 61, in Prog 417 files; P-35 Hist Rpt, Aug 61.

7. Ltr, LtCol T.O. Haig, Dir/P-35, to LtCol E.J. Istvan, SAFMS, 9 Nov 61, subj: Program Chronology, with incls, in Prog 417 files; P-35 Hist Rpt, Aug 61; TWX, SAFMS-DIR-61-107, SAFMS to SAFSP, 18 Aug 61, in Prog 417 files.

8. Program 35 Satellite System Development Plan, prep by P-35 Ofc, 31 Aug 61.

9. TWX SAFSP-25-9-19, SAFSP to SAFUS, 25 Sep 61, in SP-3 files, Funds; TWX SAFMS-INS-61-136, BrigGen R.J. Curtin, SAFMS, to MajGen R.E. Greer, SAFSP, 21 Oct 61, in Prog 417 files.

10. Ltr, Haig to Istvan, 9 Nov 61.

11. *Ibid*; P-35 Chronology, 25 Oct 61-5 Jan 62, in Prog 417 files; P-35 Chronology, 25 Feb-24 May 62, same files.

12. Ltr, Haig to Istvan, 9 Nov 61; P-35 Chron, 25 Oct 61-5 Jan 62; memo for record, LtCol T.O. Haig, Dir/P-35, 14 Dec 61, subj: Report of Trip to Hq AWS and SAFUS from the 6 thru 9 Dec 61, in Prog 417 Trip Rpt file.

13. Memo for record, F.C. Runge, Dep Dir/P-35, 21 Feb 62, subj: Scout Spare Parts; P-35 Chron, 25 Oct 61-5 Jan 62 (which actually continues into Feb 62!).

14. See memo for record, LtCol T.O. Haig, Dir/P-35, 23 Mar 62, subj: Trip Report from 16 Mar 62 through 22 Mar 62, in Prog 417 Trip Rpt file. Judgments on the mental state and outlook of NASA people below the top level are those of the author, not of program officer personnel--who either stiffled their frustrations or ignored them.

15. This was Scout vehicle 111, prototype spacecraft F-1; see P-35 Chron, 25 Feb-24 May 62.

16. P-35 Chron, 25 Feb-24 May 62.

17. Ltr, Col B.H. Kucheman, SSD, to Col H.L. Evans, D/Dir Sat Sys, 28 May 62, subj: Program 35, in Haig files; P-35 Chron, 25 Feb-24 May 62 and 25 May-30 Jun 62; ltr, Evans to Kucheman, 23 May 62, subj: Program 35, in Haig files.

18. Ltr, Kucheman to Evans, 28 May 62.

19. NASA/DOD Scout System Organizational Agreement, signed by Dr. H.E. Newell, Dir/Ofc Space Sys, NASA Hq, and Col R. Nudenberg for MajGen O.J. Ritland, Dep to Cmdr AFSC

for Manned Space Flt, 21 Jun 62; Joint Operating Agreement NASA/DoD Scout Launch Operations at PMR, same date, same signators plus concurrent signature of BrigGen Joseph Cody, Cmdr 6595th ATW, both docs in 417 ofc files.

20. Memo for Record, MajGen R.E. Greer, Dir/SAFSP, 22 Jun 62, no subj, in 417 Ofc files.

21. Ltr, LtCol T.O. Haig, Dir/417, to LtCol E.J. Istvan, SAFSS, 20 Nov 62, subj: Program Chronology, in Haig files.

22. Interview, LtCol T.O. Haig, Dir/Prog 417, by Perry, 19 Feb 64, 15 Nov 63; various launch rpts dtd Sep 62, in Prog 417 files.

23. Ltr, Kucheman to Evans, 28 May 62, citing Haig; interview, LtCol T.O. Haig by R.L. Perry, Hist Ofc, 10 Dec 62, 15 Nov 63.

24. TWX SAFSS-1-62-156, to SAFSP, 16 Oct 62, in Haig files; ltr, MajGen R.E. Greer, Dir/SP, to D/Launch Vehs, SSD (Col Eichel), 25 Oct 62, subj: Project 417 Follow-on Booster Procurement, in Greer files.

25. Authorization for the Eglin move was contained in TWX SAFSS-6-62-159, to MajGen R.E. Greer, Dir/SP, 24 Oct 62, in Haig's files; interviews with Gen Greer (24 Oct 62, 30 Jan 64), Col R.A. Berg (23 Jan 64) and Col Haig (15 Nov 63, 19 Feb 64) provided most of the details of the Eglin episode, although a copy of the presentation to Undersecretary Charyk still is preserved in Haig's files.

26. Interviews, Haig (11 Dec 62, 15 Nov 63, 19 Feb 64) and Greer (24 Oct 62, 30 Jan 64) by Perry; ltr, Haig to Istvan, 24 Jan 63.

27. TWX SAFSS-6-62-159, to Greer, 24 Oct 62.

28. Ltr, LtCol T.O. Haig, Dir/Prog 417, to 6594th ATW (Col Villars), 6 Oct 62, subj: Program 417 Analysis and Evaluation, in Prog 417 files.

29. Interview, Col W.G. King, Jr, Dir[redacted]by R.L. Perry, 20 Nov 62, 20 Feb 64; TWX SAFSS-6-62-159, 24 Oct 62.

30. TSX SSZH-3-12-259, MajGen R.E. Greer, Dir/SP, to Col W.K. Kincaid, Cmdr 6594th ATW, 4 Dec 62; ltr, LtCol G.W. Adams, D/Dir SLV-I, to Dir/417, 17 Dec 62, subj: SLV-ID #126, in 417 Prog Ofc files: FTV 0240; ltr, Haig to Istvan, 24 Jan 63.

31. Ltr, Adams to Dir/417, 17 Dec 62, with handwritten notes apparently by a 417 program officer.

32. Ltr, Greer to Kincaid, 4 Dec 62.

33. Ltr, Haig to Istvan, 24 Jan 63; ltr, Col W.K. Kincaid, Cmdr 6594th ATW, to Dir/417, 21 Dec 62, subj: 3502 Special Evaluation . . . 2-8 November 1962; ltr, LtCol T.O. Haig, Dir/417, to MajGen R.E. Greer, Dir/SP, 14 Jan 63, subj: 6594th ATW Special Evaluation of FTV 3502, in 417 files.

34. Interview, Haig, 15 Nov 63; Greer, 23 Jan 64; 417 Briefing, prep by Haig for J.V. Charyk, SAFUS, 7 Jan 63, in 417 files: Briefings.

35. 417 Briefing, 7 Jan 63; TWX SAFSS-6-63-04, to SAFSP, 17 Jan 63, in Haig files.

36. Rpt, 417-I Proposal, prep by RCA, 30 Jan 63, in 417 files: 417-I.

37. Memo for record, LtCol T.O. Haig, Dir/417, 21 Feb 63, subj: Report of Trip to RCA-AED and Pentagon 14-15 Feb 63, in 417 ofc Trip Rpt file.

38. Proposal for Continued Operation of P-35, aprox Feb 63, in Haig files.

39. Ltr, LtCol J.R. Smith, 417 Dir, to LtCol E.J. Istvan, SAFMS, 1 Apr 63, subj: Program Chronology, in Prog 417 files.

40. Ltr, W.M. Menco, Subv, L.A. Ofc CVC, to LtCol T.O. Haig, et al, Prog 417, 28 Feb 63, subj: Program 417, Scout S-126

Flight Results, Real Time Evaluation of, in Prog 417 files: 0240; ltr, Haig to LtCol E.J. Istvan, SAFMS, 12 Jul 63, subj: Program 417 Chronology; TWX SSZH KNEEDEEP 01-21-2, Proj Ofc (at VAFB) to MajGen R.E. Greer, Dir/SAFSP, 21 Feb 63, in Prog 417 files: 0240.

41. TWX TWOB 01-26, 6594th ATW to 417 Prog Ofc, 26 Apr 63, in Prog 417 files: 0240.

42. Memo, Col J.R. Martin, Dir/Ofc Space Sys, SAF, to DDR&E, 12 Mar 63, subj: Comparison Between NIMBUS and Proposed 417-I, in Prog 417 files: 417-I.

43. Memo for record, LtCol T.O. Haig, Dir/Prog 417, 16 Mar 63, subj: Trip to RCA/AED and Pentagon, 11 thru 15 Mar 63, in Prog 417 trip rpt files.

44. TWX SAFSS-6-63-47, DNRO to SAFSP, 28 May 63, in Haig files; rpt, Prog 417 Program Direction Plan, 21 Oct 63, in Haig files.

45. Ltr, LtCol M.F. Gregg, Dir/SLV-I, to 417 Dir, 19 Mar 63, subj: NASA support of 417; ltr, LtCol J.R. Smith, 417 Dir, to SLV-I Dir, 21 Mar 63, same subj; ltr, R.B. Morrison, Dir Launch Vehs and Propul Prog, NASA (Washington), to SLV-I Dir, 24 May 63, subj: Scout Procurement, all in 417 files.

46. Ltr, Haig to Istvan, 12 Jul 63; ltr, K.W. Greaves, CVC, to LtCol T.O. Haig, 417 Dir, 29 Apr 63, subj: Program 417, Scout S-121 Flight Results, Real Time Evaluation of; TWX KNEEDEEP 26-4-04, 417 Dir to SAFSS, 26 Apr 63, in Prog 417 files: 1298.

47. [redacted]-5-55, SLV-1 Dir to NASA Washington, 17 May 63, NASA Santa Monica to SSD, 21 May 63, in Prog 417 files.

48. Ltr, LtCol M.F. Gregg, SLV-1 Dir, to Cmdr PMR, 23 May 63, subj: Range Support for SLV-1D Program; TWX SSVBD-22-5-63, SLV-1 Dir to NASA Washington, 24 May 63; memo for record, Capt R.L. Geer, Prog 417, 6 Jun 63, no subj, all in Prog 417 files: Booster.

49. Resume of Program 417 Briefing for Undersecretary B. McMillan, 20 May 63, in Prog 417 files, indicates that McMillan agreed with that viewpoint.

50. Memo for record, prep by Capt R.L. Geer, 417 Prog Ofc, 7 Jun 63 , subj: SSVB Support of 119-121 Investigation Board Recommendations, in Prog 417 files; memo for record, prep by Col R.A. Berg, V/Dir SAFSP, 10 Jun 63, subj: Visit of Dr. McMillan, 10 June 1963, in SP-3 files: Funding.

51 TWX TWOP-3/14-6-2, 6594th ATW to SSD, 15 Jun 63; TWX SSZH-19-6-263, 417 Ofc to 6594th ATW, 9 Jun 63; TWX TWOP-3-25-6-6, 26 Jun 63, all in Prog 417 files: 0243.

52. Rpt, Preliminary Study of Two Tone Command System versus a Receiver Clock, 13 Jun 63, in Prog 417 files; TWX SSZH-5-3-96, 417 Ofc to SAFMS, 5 Mar 63, and TWX TWRDA-8-3-5, 6594th ATW to SAFSP, 8 Mar 63, in 417 Ofc files: 0240.

53. Haig interview, 10 Dec 62.

54. Ltr, LtCol T.O. Haig, Dir/Prog 417, to all 417 Pers, 24 Jul 63, subj: Letter from Director, 417, in Haig files; ltr, Haig to SAFSS, 18 Sep 63, subj: Program History, in Haig files; notes in 417 ofc files re notable events after 1 Jul 63.

55. Ltr, Col L.A. Perry, D/Spt Sys, 6594th ATW, to SLV-1 Dir, SSD, 18 Aug 63, subj: Proposed Scout Facility, in Prog 417 files.

56. Ltr, LtCol T.O. Haig, Dir 417 Prog, to SAFSS, 23 Sep 63, subj: Processing History of Scout 132, in 417 files.

57. Ltr, Haig to SAFSS, 23 Sep 63; interview, MajGen R.E. Greer, Dir SAFSP, by R.L. Perry, 14 Nov 63; ltr, LtCol T.O. Haig to Dan Kimball, Chm Bd Aerojet Gen Crop, 31 Jul 63, no subj, in 417 files.

58. Memo for record, prep by Capt R.L. Geer, 417 Dir, 6 Aug 63, subj: Trip Report to Aerojet Solid Rocket Plant, Sacramento, Calif, 5 August 63, in 417 ofc trip rpt files; ltr, Haig to SAFSS, 23 Sep 63.

59. Ltr, Haig to SAFSS, 23 Sep 63; TWX VWZC-7-329(3224), 6595th ATW to SLV-1 Dir, 22 Jul 63, in 417 ofc files.

60. Ltr, B. McMillan, SAFUS, to R.C. Seamans, Assoc Admin, NASA, 28 Jun 63, no subj; ltr, Seamans to McMillan, 15 Jul 63, no subj; ltr, LtCol T.O. Haig to SAFUS, 15 Aug 63, subj: Comments on Letter dated 15 July 63 from Dr. Seamans to Undersecretary McMillan, all in 417 ofc files.

61. Ltr, Haig to SAFSS, 23 Sep 63.

62. Ltr, LtCol T.O. Haig, Dir/Prog 417, to SLV-1 Dir, 13 Jun 63, subj: Program 417 Additional Booster Procurement; ltr, LtCol M.F. Gregg, SLV-1 Dir, to NASA Washington, attn W.A. Guild, 2 Aug 63, subj: Amendment to Delivery Order 63-32; ltr, R.D. Ginther, Ch, Small Vehs, NASA, to SLV-1 Dir, 14 Aug 63, subj: Amendment to Delivery Order 63-32; ltr, Gregg to Haig, 20 Aug 63, subj: Follow-On SLV-1A procurement; ltr, Haig to SLV-1 Dir, 23 Aug 63, same subj, all in 417 Ofc files.

63. Ltr, LtCol T.O. Haig, Dir/Prog 417, to SLV-1 Dir, 11 Sep 63, subj: Performance of X-258 Motor; ltr, LtCol G.W. Adams, D/Dir SLV-I, to Haig, 13 Sep 63, same subj, in 417 ofc files.

64. Rpt, Program 417 Program Direction Plan, 21 Oct 63, in Haig files; undated excerpt from "Minutes of Meeting of S-132 Flight Evaluation Board," in 417 Ofc files.

65. Memo for Record, LtCol T.O. Haig, Dir/Prog 417, 7 Oct 63, subj: Trip Report to Wash D.C. 3 & 4 October 63, in Prog 417 trip rpt files.

66. TWX SAFSS-6-63-73, SAFSS to SAFSP, 8 Oct 63, in Haig files.

67. TWX [redacted]7-10-17, SLV-1 Dir to NASA, 7 Oct 63; TWX SSVBK-10-38, SLV-1 Dir to NASA, 10 Oct 63, both in 417 ofc files.

68. TWX SAFSS-6-63-78, SAFSS to SAFSP, 23 Oct 63, and TWX SAFSP[redacted]21-10-1, SAFSP to SAFSS, 21 Oct 63, in 417 ofc files.

69. TWX [redacted] 25-10-44, SLV-1 Dir to NASA, 25 Oct 63, in 417 o.

70. Ltr, LtCol T.O. Haig, Dir/417, to Col R.W. Hoffman, D/Space Launch Vehs, SSD, 8 Oct 63, subj: Study of Booster Support for Program 417; TWX SAFSS-6-63-78, 23 Oct 63.

71. Proj 417 Program Direction Plan, 21 Oct 63, in Haig files; memo for record, LtCol T.O. Haig, Dir Prog 417, 17 Jun 63, subj: Trip Report 13-14 June 63 to Hqs SAC and to RCA/AED, in 417 ofc trip rpt files.

IX THE E-4 MAPPING SATELLITE (PROGRAM IA)

Development of a mapping and charting satellite had been a cherished Air Force dream for at least two years before SAFSP inherited the mantle of satellite reconnaissance responsibility--but progress had remained in the dream category. The requirement had been defined in September 1958 (although considered abstractly even earlier). By the following January the notion had been translated into a proposal for a recoverable capsule system capable of taking pictures with high geometric fidelity and correlating them with the products of a stellar-image recording camera. Called E-4, the proposed system was considered a companion to the E-5 surveillance system then being defined. Although the Ballistic Missiles Division and the Air Research and Development Command heartily favored starting development, even seeming to prefer the E-4 to the E-5, the Air Staff was never more than lukewarm. In part because highly influential intelligence officers withheld firm support, the E-4 took shape as a somewhat tenuous development which was in direct competition with a proposed ARPA-sponsored interim mapping system and with the Argon system, being covertly developed under Army auspices. In May 1959, ARPA directed the Air Force to cancel work on the E-4 mapping camera program. Most contracts were dropped the following month, although the photographic laboratory at Wright Field continued to fund related camera developments without calling much attention to the effort. The cancellation came, somewhat disconcertingly, on the day that Lockheed finished the initial version of the development plan.[1]

Samos program managers were never enthusiastic about Argon. The system had serious performance limitations that chiefly arose in a policy of making technical compromises to insure early delivery. Plans in October 1960, when the question of mapping satellites began attracting Undersecretary Charyk's attention, called for a total of four Argon launches between December 1960 and August 1961.

On 18 October 1960, Major C. E. James of the newly organized Samos Washington office met with Dr. Charyk to discuss geodetic and mapping satellites. He brought the undersecretary up to date on the status and prospects of Argon and then explained that the Air Force had a camera known as the [redacted] (actually the "applied research" development undertaken upon formal cancellation of the E-4 camera) which represented the logical follow-on to Argon. Two were scheduled for completion by early 1961 and long-lead-time provisions had been made to purchase seven more. In James' opinion, the system represented the best the existent state of the art could provide. He advised

Dr. Charyk that the camera system could be readied for flight in an E-5 capsule by August 1961. (By using the considerably greater thrust of an Atlas booster, the E-4 avoided design compromises inherent in the Thor-boosted Argon.)

The E-4 had other attractions. It promised new avenues for the future, seeming to be adaptable to evolution toward a long-term objective defined in September 1960 by the National Security Council.* Moreover, an E-4 program under SAFSP auspices would eliminate any need for continuing the cumbersome Argon management complex, which then included the Army Mapping Service, the National Photographic Interpretation Center, the Central Intelligence Agency, and the West Coast Argon office. Finally, and most important, E-4 promised better results than Argon.

Convinced, Charyk authorized the BMD-WADD (Wright Air Development Division) organization to plan for early inclusion of the [redacted] camera in the Samos program. For the moment, he withheld any authorization to schedule use of the [redacted]

Although Dr. Charyk and his staff were relatively enthusiastic about the prospects of the E-4, neither General Greer nor Colonel King looked on it so favorably. Conceding the feasibility and general desirability of an E-4 system,* they nevertheless questioned the wisdom of substituting a mapping satellite for any of the E-5 payloads then on schedule. Charyk, who thought less highly of the E-5, directed in December that the mapping camera be integrated in the total Samos effort as soon as possible and that the existing contracts be expanded to provide for three flight cameras, two test articles, and four follow-on models. (That total matched the figure of nine that Major James had described as "available" two months earlier.)

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* Although the evidence is not entirely clear, it would appear that a discussion of mapping satellites during the September meeting of the National Security Council touched off Charyk's interest.

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* The objective of the E-4 development was a system capable of giving position accuracies of 500 feet or less. Based on the usual Atlas-Agena B combination, the recovery capsule was nearly identical to that of the E-5, having a 72-inch diameter and being 84 inches long. The mapping camera had a six-inch focal length; the stellar-indexing camera a focal length of three inches. The customary gas-reaction jets were to control attitude during a five-day mission with an apogee of 178 nautical miles. Ground resolution would be, under good conditions, on the order of 150 feet, assuming a 90-mile perigee over the target area. The usual near-polar orbit was planned. The f/5.6 lens of the mapping camera was considered by reconnaissance camera experts to be the "best . . . available today for photogrammetic purposes." It had an axial resolution of 60 lines per millimeter with a distortion of 10 microns--which reduced to two microns upon calibration. Some 4000 feet of nine by nine-inch film would be carried and retrieved. Shutter speeds could be varied over a range from 1/50 to 1/800 seconds. Fudicial and reseau edge markings on the film were to be provided, based in part on a timer with an accuracy of .001 seconds. The f/2.5 stellar image camera used 4.5 by 4.5-inch film frames, exposing each frame for four seconds to provide an elongated tracer of star images on a total of 2000 feet of film. Each mission could theoretically provide high quality photographs of about 50 million square miles of Sino-Soviet territory.

Flight hardware (Agenas and equipment) for three flights was to be purchased or transferred from other sub-programs. The booster problem was to be solved by using Atlas boosters made available by the decision to fly F-2 (ferret) subsystems atop Thors, and the matter of inserting E-4's into the tight schedule of E-5 and E-6 flights by slipping the entire sequence of shots.[2]

Instructions and guidance along such lines came into General Greer's complex gradually, over a period of several weeks. Late in December 1960, Greer concluded that the net effect of redirection involving the E-4 and the F-2 had been to create two additional Samos technical programs. He cautioned Charyk that "nothing comes free in this business." Manpower and dollar increases were inevitable if the directions were carried out. The E-4 program promised to be particularly costly, he warned, since the implication of earlier directives was to give the E-4 precedence over both the E-5 and E-6. Greer was certain Charyk had not intended that result, and he was also sure that Charyk had not fully analyzed the cost impact of modifying Agenas from an F-2 to an E-4 configuration.[3]

After weighing the various considerations, Undersecretary Charyk in February 1961 decided that he wanted an E-4 but that it would have to be developed and tested within the limits of existing funds. He continued to insist, however, that rescheduling boosters and launches would permit the E-4 to progress without grossly affecting any of the search or surveillance payload programs. But partly in deference to the existence of Argon and the certainty of Army objections should it become known that revival of the E-4 program was being planned, he decided to conceal the program's existence. The term "Program lA" was generally substituted for "E-4" as a means of obscuring project intentions. That subterfuge was also an element in the more widespread effort to remove all reconnaissance satellite effort from general view.

By early April 1961, the E-4 had acquired relatively firm configuration characteristics and had made the transition from proposed effort to funded procurement.* An effective working relationship between the Aeronautical Systems Division (ASD) and SAFSP had been created, and progress seemed to be quite good. Both the technical and the financial details had received Charyk's specific approval following a general presentation of 7-8 March, although the West Coast group remained rather "bearish" on the whole issue.[4]

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* Lockheed was the system integrating contractor, under letter contract AF04(647)-841, issued on 6 April 1961. The original work statement covered systems engineering and vehicles for three flights plus long lead time items for five more. Fairchild Camera and Instrument Corporation had payload development responsibility under letter contract AF33(600)-42926, issued by the Aeronautical System Division's (ASD) Reconnaissance Laboratory on 25 March. (Fairchild actually

The ambitious E-4 program conceived during the Samos reorganization of August-September 1960 began to lose stature the following spring. On 28 March 1961, Deputy Secretary of Defense Roswell Gilpatric confirmed Air Force responsibility for development and operation of all defense department reconnaissance satellites, but also made the Army responsible for establishing and managing "a single geodetic and mapping program" to meet defense department requirements.[5] Within two weeks, the Army's chief of staff had contacted his Air Force counterpart, General T. D. White, to request nominations to an "integrated three-service" group to plan for mapping satellites--under Army cognizance. The first meeting was held early in May, and it was immediately apparent that the Army saw the Gilpatric directive as a mandate for establishing a new major research and development effort in satellite mapping and geodesy. The Air Force inevitably disagreed. The only product of the meeting was a decision to collect requirements statements from all three services.

The next meeting, on 11 May, was called on short notice but found the Air Force more determined than ever that reconnaissance

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accepted six days later.) Funds were initially released to ASD on 10 March. A total of [redacted] was set aside for "Program 1A," the coverage extending through four fiscal years until fiscal 1964, but the bulk of that amount falling due in fiscal year 1963. Schedules called for initial launches in March, June, and September 1962 with the first of the five supplemental payloads going into orbit in April 1963.

satellite research and development should not be parceled out according to camera focal length--which seemed in some respects to be the Army's goal. On instructions from Charyk, the Air Force representative refused to discuss research and development in satellite geodesy, characterizing it a matter for secretarial resolution. Typically, the tri-service committee was unable to agree on anything significant, adjourning on the note that what was immediately needed was a commonly accepted definition of geodesy, some agreement on targeting requirements, and a standard viewpoint on data processing requirements.[6]

Nevertheless, the lines had been drawn and under the rules outlined by Gilpatric the E-4 program had become quite vulnerable. Yet had the matter remained one for resolution by a tri-service committee, Charyk and Greer might well have flown the E-4 before any decision could be taken. However, in late May 1961, the mapping satellites issue had been passed to the Directorate of Defense Research and Engineering (DDR&E) for resolution, and the E-4 became but one of three proposed systems. Early in June, Gilpatric authorized continuation of the procurement of four cameras in the E-4 (Program lA) configuration but instructed Charyk to suspend plans for buying and launching boosters and space vehicles. There still was hope, of course, that a decision to confirm proposed flight schedules would follow completion of an evaluation--but the hope was rather faint. Charyk therefore directed that all E-4 activity not essential to completion of four basic payloads (including accessories) should be halted. He subsequently modified the "complete stop" order to permit Lockheed to work on capsule engineering essential to creation of an "appropriate" interface between capsule and payload and to insure compatibility of the payload with the capsule environment, but even then the Lockheed work was carefully limited.

For another six months, payload development continued at a slow pace and on a low key. It appeared to be progressing remarkably well, on the whole, a situation that most observers credited to the ability and industry of the immediate program officers (Mr. Leonard Crouch at ASD and Major Edward J. Conway of General Greer's establishment). No firm decision on the future of the program had yet emerged from DDR&E, and Charyk seemed content not to push the issue. In October, he discussed mapping satellites with Dr. E. A. Fubini of DDR&E and got approval of a plan to bring the E-4 payloads to a state of flight readiness and hold them there, the objective being to provide the least possible delay between a launch decision and an actual launch. He told SAFSP to begin putting together engineering and cost details for a "hold" program. General Greer's people, though reasonably optimistic about the promise of the E-4 camera and the functional effectiveness of the system, were not particularly encouraging--estimating that it would cost [redacted] and [redacted]--not counting launch and recovery charges.[7]

Charyk, who had preserved the E-4 program through a succession of administrative mishaps and who had somehow managed to keep it alive in the face of a formal Gilpatric directive that denied his authority to do so, reacted angrily to the cost and time figures. "It appears that SAFSP does not want to do this job," he told General Curtin. "The system is obviously gold plated and fat. It is necessary that the program be scrubbed down to the hard core and re-estimated."[8]

Though unpalatable, the figures nevertheless proved to be well founded. By the end of the year, Charyk was apparently resigned to the fact that there was no prospect of early flight for the E-4 payloads then approaching completion. Early in January 1962, he advised Gilpatric that as they were completed the E-4 payloads were being stored in a readiness-in-nine-months flight condition, and that a decision to fly would require the provision of substantial funds for launch, booster, and space vehicle costs. And there the E-4's remained.[9]

The decision was not wholly one of institutional prerogatives, however much that seemed to be the case in 1961. In fact, the E-5 launch, orbital, and recovery system on which E-4 relied had been progressing with notable lack of distinction through 1961. Whether the E-5 camera system would work properly remained uncertain (and was not to be established until a modified camera was successfully flown in the Lanyard program, in July 1963: results were rather disappointing). But that the Atlas, Agena, and recovery subsystem were marginally capable, at best, was apparent early. In consequence of those unhappy developments, E-5 was cancelled in December 1961. With it went much of the potential of E-4.

Also significant was the development of a mapping and charting capability in Corona. Although the superb capability that would appear with the eventual introduction of a dual integrated stellar-indexing camera (DISIC) as part of the Corona payload was not evident in October 1961, when it was decided to add an indexing camera to Corona, Lockheed and the Corona program office could by then confidently anticipate that outcome. The Argon program did not completely run down until 1964, but even earlier Argon's spotty record of success, index-camera development, and the changing concept of geodesy program requirements had obviated any real need for specialized mapping camera systems.

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VI NEW DIRECTIONS IN SATELLITE RECONNAISSANCE
(August 1960 - May 1961)

Technological considerations played an incidental role in the August decision to shift Samos project responsibility from the middle echelons of the Air Force to the Office of the Secretary. The implications of the U-2 affair, high-level disenchantment with the tortuous processes of conventional Air Force program management, the resistance of the Air Research and Development Command (ARDC) and the Air Staff to Samos policy decisions made at the secretariat level, and the shift in program objectives from surveillance to reconnaissance were largely innocent of technical motivation. Although the simmering readout-versus-recovery controversy of 1959-1960 had a basis in technical uncertainty, financial factors were more important than technical factors in the eventual shift of emphasis to recovery modes. The dichotomy in viewpoints on concurrency and on who should operate reconnaissance satellites was unaffected by specific program achievements--or their absence.

Nevertheless, technology helped reshape the Samos program in the late months of 1960 even though management and organizational matters held the spotlight. The decision to develop a new surveillance system was the most obvious facet of Samos realignment during that period. Thereafter, the fact that technical and policy decisions were handled as one tended to obscure the fact that technical program matters were receiving increasing attention. Once indecision on how the program should be conducted had been eliminated, it became possible to concentrate on what should be done. Insulated from the inputs of multi-layers of command-level and Pentagon officials, Brigadier General Robert E. Greer and Undersecretary J. V. Charyk could devote attention to selecting the best possible course of program development and to seeing that it was pursued to a meaningful conclusion. In itself, that circumstance substantially reduced the confusion and uncertainty which had characterized the entire Samos effort until late 1960.

Those whose views were influential in charting a new course for Samos were relatively few in numbers. The shift in emphasis from readout to recovery had been urged late in 1959 by Harold Brown and John Rubel of the Directorate of Defense Research and Engineering. As he became increasingly familiar with the details of Samos, Charyk gradually changed his views on concurrency, operational responsibility, and readout (particularly on the need for elaborate ground stations) in the period between March and June 1960. The emergence of new reconnaissance requirements, early in July 1960, and their basic shape, certainly were influenced by the abrupt termination of the U-2 program as well as the continuing disappointments of the Corona program.

With allowances for differences in detail and intensity, the paths laid out by ARDC and Air Staff officials generally included concurrency and placement of prime development emphasis on readout modes of satellite reconnaissance. Strategic Air Command control of the reconnaissance process was generally assumed, though there was no common agreement on the timing of such a move. Concurrency, readout, and SAC operational responsibility for Samos were interdependent; none made sense without both of the others.

At the program office level, concurrency, readout, and SAC control of operations were not highly regarded theses. Colonel William G. King, Jr. had been Samos project director since July 1959. His immediately previous experience had involved repairing and ministering to a grievously mismanaged Snark missile program. He had not been long with Samos before concluding that the program was badly overextended, and like virtually all space-program specialists in BMD he quickly decided that concurrency was wholly inappropriate for satellite development. During the spring of 1960 he had consistently urged the advantages of recovery over readout, had argued to a hostile Air Staff that the Corona management approach was more appropriate for Samos than the then-accepted program philosophy, and had persistently urged program simplification. His views almost certainly influenced Charyk's

27 May 1960 instructions to employ "off the shelf" and "current state-of-the-art" techniques as a means of Samos program acceleration.*

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* The matter of how greatly Colonel King's views influenced Undersecretary Charyk cannot be entirely resolved. Surviving documents clearly indicate, however, that Colonel King was well ahead of his contemporaries in urging cancellation of Subsystem I, termination (or complete redirection) of the readout program, creation of a new recoverable-capsule photo-satellite, and establishment of "management by exception" channels for the Samos program. His recommendations met with a tepid reception in BMD headquarters, a cool response in ARDC headquarters, and icy blasts from most of the Air Staff. (The Assistant Chief of Staff, Intelligence, considered King's views on readout and *Corona* indicative of disloyalty to the Air Force, which suggested both the intensity of the Samos controversy and the objectivity displayed by some participants.)

The DDR&E viewpoint, particularly as expressed in reports prepared under Dr. W. O. Baker and Dr. B. H. Billings, was much closer to the real world than anything that emerged from Air Staff deliberations during the first half of 1960. It is worth noting, however, that the most sweeping DDR&E recommendations for program reform did not appear until *after* the U-2 affair; Baker and Billings took their final stands in June. King and Charyk had resolved their respective doubts by May. The frequency of briefings, presentations, discussions, and "think papers" during the February-June 1960 period, and the high mortality rate of documents in that period, make it quite difficult to trace either the origins or the fates of most proposals. Nevertheless, this much is clear: by mid-May 1960, King and Charyk were in general agreement on what should be done to improve the status of the Samos program; King had arrived at such conclusions first; at least one careful analysis prepared by King reached Charyk without going through chain-of-command sanitizers; and the several echelons between King and Charyk were not at all in sympathy with their viewpoints.

It is also clear that various technical developments entirely independent of the background Samos controversy began to influence the program in the spring of 1960. On 24 March, more than a month before the U-2 affair and two months before Charyk's policy pronounce- [redacted] The contractor estimated that the system could be made available in a relatively brief time because the technology was well within the current state-of-the-art. Providing six- to eight-foot ground resolution and covering 97 per cent of the vital target areas, having a five-day orbital life, the proposed reconnaissance system generally conformed to the ground rules specified by Charyk. It considerably surpassed in promised performance the requirements subsequently detailed by USIB. [redacted]

Still later, on 20 July, [redacted]

[redacted]

In a fashion that was not unique with Eastman Kodak, the firm circulated the essentials of its proposal through other than the "normal" channels at WADD. In a mid-June conversation with Charyk, Dr. E. H. Land described the proposed system in highly favorable terms. It is probable that Eastman also submitted the proposal to the CIA; that agency certainly was familiar with the technical details as soon as was Charyk.

Later that month, at Charyk's request, the company forwarded to the Undersecretary a copy of the technical proposal for [redacted]

[redacted]

On 5 July, after having digested the [redacted] proposal, Dr. Charyk met with A. B. Simmons of Eastman Kodak to discuss both [redacted]

Although Eastman was gravely concerned with keeping knowledge of its two proposed approaches closely confined, that was particularly difficult in the existent environment. By late July, details were generally known throughout the Samos structure, within the Reconnaissance Laboratory at WADD, and in several elements of the Air Staff, It was [redacted] that General White mentioned to General Greer during their meeting on 3 August; what he apparently did not mention was that one day earlier, on 2 August, the Air Staff had decided to [redacted] made available to support the program.

What followed, for nearly a week, was a small comedy of errors. Pentagon instructions to WADD to act at once on the [redacted] proposal brought an anguished response from Wright Field that the proposal had never been formally submitted there, having been originally prepared for a competition [redacted] had won. No copy was available at Wright Field. Reconnaissance Laboratory officials quietly contacted the local Eastman Kodak [redacted] He was told that it had originally been left with "a high USAF official." That advice, transmitted to Eastman's home office at 9 p.m. on 5 August, brought a 10 p.m. call from Simmons, asking if Charyk was the "high official" meant. The Kodak representative in Dayton told Simmons that the Air Force was "sincerely interested" in starting a research sequence leading to operational hardware. Simmons remarked, tartly, that Eastman had originally proposed nothing more than a breadboard model and that the sudden upsurge of interest was rather startling.

In the meantime, the Pentagon instructed WADD to proceed as far with [redacted] [redacted] would permit and that more money would certainly be approved later. Further conversations between Wright Field and Rochester caused Simmons to retreat to the local CIA office, from whence he could privately phone the responsible

Air Staff office. Eastman, he remarked, felt that WADD's participation implied "rather routine handling." On the contrary, he was advised, WADD was in the process of getting increased authority. Somewhat cynically, Simmons said that "his bosses" were certainly interested in working on a "bigger program," but that they would prefer to work with the people building the vehicles--BMD. Simmons also expressed concern at the widening circle of knowledge, mentioning that he had Charyk's agreement to limit the number of "witting" individuals.[2]

As it happened, Eastman Kodak's obvious reluctance to undertake the [redacted] program under "normal" Air Force operating procedures coincided in time with the decision to shift Samos management to the Air Secretariat level. On 13 August, complying with instructions from Charyk, the Air Staff rescinded that portion of the original directive which passed responsibility to WADD.*

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* The attempt to bring Wright Air Development Division's Reconnaissance Laboratory more immediately into the Samos program was part of a long-term effort to find a broader mission for the entire Wright Field complex. It was also, almost certainly, part of General Schriever's wide-front attempt to fix Samos responsibility firmly within the Air Research and Development Command. While theReconnaissance Laboratory employed many highly qualified scientists and engineers and would surely continue to make major contributions to the advancement of the photo-reconnaissance arts, there was an obvious reluctance on the part of many in industry and in the Air Secretariat to entrust any new major program management responsibilities to WADD. The "coordinated program approach" then being

Procurement of [redacted] work was to be undertaken through BMD channels and was to be managed as part of the total Samos program rather than as a separate camera development project.[3]

The shift of responsibility to BMD meant, in practice, that the existent Samos program office became the Air Force focal point for [redacted] activity. Eastman readily accommodated the notion of operational hardware development rather than an experimental camera program. In forwarding copies of the earlier studies to BMD on 13 August, Eastman proposed a 90-day Phase I stage (design to mock-up) to cost [redacted] and a subsequent Phase II effort to include design, construction, test, and flight test of development models and prototype camera systems. Eastman noted the impossibility of projecting development costs until completion of the Phase I activity and acknowledged the uncertainty of compatibility between the camera system and available boost, orbit, and recovery subsystems. [redacted]

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urged by ARDC promised to involve semi-autonomous elements of several divisions in a single technical effort, thus diluting the effectiveness of the decision process and making major elements of the Samos project dependent on actions that could not readily be controlled by program managers. Distrust of WADD competence was inherently part of the wider-based effort to make Samos a special agency assignment.

Within 24 hours of receiving the Eastman studies and the summary proposal, BMD was processing a letter contract.[4] Functional transfer of responsibility from WADD and authorization for sole source procurement (without competition) were part of the process.[5]

At that point, yet another factor was introduced into the equation. Space Technology Laboratories (STL) in August had responded to an earlier BMD inquiry into the feasibility of covertly launching and operating an orbital reconnaissance system. STL had attempted to specify means of satisfying three basic criteria: definition of an orbital life and vehicle attitude adequate for the collection of useful photographs of Soviet ground installations; an acceptable compromise between good photographic resolution and system simplicity; and covert launch from within the continental United States. For purposes of study and analysis, STL projected a desired first-launch deadline of July 1961.

The scheme that STL proposed in August 1960 was based on inserting an Atlas D nose cone into a polar orbit. Fired south from Point Arguello, the reentry vehicle theoretically could make 16 passes before reentering. (The orbit was arbitrarily established to provide 90-minute circuits, so 16 passes would require 24 hours.) The vehicle was to be spin stabilized, was to include a 24-inch focal length panoramic camera, and was to employ five-inch film exposed in 40-inch strips during alternate axial rotations. Alignment of the spin axis to insure that it would be parallel to the earth during the critical period of each pass would provide good camera orientation. Recovery of the film capsule (comparable to the instrumentation capsule in a test ICBM warhead) was predicated on use of the well-proved AVCO Shape 52 reentry vehicle and a parachute. In many of its technical details, the STL proposal of August 1960 was strongly reminiscent of the March 1958 Lockheed-Fairchild approach which had led ultimately to Corona.

The "covert launch and operation" requirement was to be satisfied by a public explanation that repeated passes of a warhead in a polar orbit were being used to measure the effectiveness of the ballistic missile early warning system. After the ground stations had taken "sufficient" instrument readings, the nose cone would be "directed" to assume a reentry trajectory, thus simulating the actual penetration of a ballistic missile warhead.

Although plausible in a general sense, the cover story had one major conceptual flaw. In order to obtain useful photographs, the camera would have to remain in a relatively low orbit. But meaningful tests of the early warning system required a good simulation of actual warhead track: high orbit and steep reentry.[6]

Introduction of the covert operation proposal, known as [redacted] further complicated the task of reshaping the total Samos effort. Apart from the E-1/E-2 and F-1/F-2 readout programs, which still existed in depreciated form, Samos project activity included the E-5, the E-6 evaluation, and Eastman's [redacted] system. Additionally, the receipt of the first Corona photographs on 24 August had thoroughly upset earlier notions about the feasibility of a "cheap and simple" approach to satellite reconnaissance.

On 20 September, less than a week after General Greer's office acquired a legal existence, Dr. Charyk, General Greer, Colonel Paul Heran (chairman of the E-6 evaluation board), and Lieutenant Colonel James Seay (the chief procurement specialist in Greer's organization) met in the Undersecretary's office to consider an immediate course of action. After discussing both [redacted] and [redacted] reviewing the status of the readout and recovery approaches, and considering other current uncertainties, they agreed to pursue a two-phase approach which would include both E-6 and [redacted] More important, they agreed that [redacted] would be covertly developed for eventual clandestine operation.

Decisions on what techniques to pursue and how long to continue each had to be put off until the results of the Phase I [redacted] design effort had been completed. [redacted] was to be made available to fund the covert activity through the remainder of calendar year 1960. Additionally, the meeting produced a formal policy of conducting the entire Samos effort under a significantly more dense security blanket than had been the case in the immediate past.[7]

The decision to proceed with a covert program was neither sudden nor startling. Charyk had discussed the idea with Drs. John Rubel and George Kistiakowsky at least once during the week before the National Security Council meeting of 25 August, and there apparently was some discussion of the proposition during that meeting, though it did not find its way into the minutes.[8] It was almost an obvious course, in any event. The Air Force had widely publicized Samos as a reconnaissance satellite, being at least partly responsible for the Soviet Union's gradually hardening contention that reconnaissance from space was military activity which should be forbidden by international agreement. It was entirely conceivable that political necessity might someday require the United States to sign a "no space reconnaissance" agreement with the Soviets. Should the "official" Samos program have to be cancelled, for any reason, a covert effort would remain the only feasible source for vital intelligence information on heartland activity. Corona, in its original configuration, was inadequate insurance because of its resolution limitations and generally shaky performance record. Having an alternate reconnaissance program with greater promise of providing the required information on Soviet installations thus became an inevitable element of national policy.

There was a second aspect to covert development of a reconnaissance subsystem. Should the political climate remain relatively stable and the several known Samos systems survive the uncertainties of development, it would be highly profitable to have a concealed technical capability for very high resolution satellite reconnaissance. The general specifications of the E-6 were among the most ill-kept of secrets. Technical details had actually been published in one widely circulated aerospace magazine.[*] Although the Soviets might well be suspicious of such a disclosure, reasoning that no great power could unwittingly be so indiscreet, it was also possible that the tragicomic record of lax Air Force security and that service's notorious fondness for publicity would induce Soviet intelligence experts to accept the specifications as valid. In that case, the ability to fly a camera capable of 2.5-foot resolution in a satellite ostensibly designed for cameras of

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[*] Aviation Week.

10- to 15-foot resolution would constitute a highly useful reserve. It would, in effect, invoke the classical doctrine of technological surprise with the additional advantage that initial employment of the superior device need not become known to the prospective enemy.*

General Greer, whose responsibility it would be to see that the various aspects of the newly approved Samos effort were carried to fruition, found himself with two basic objectives that were not necessarily compatible. The first, derived from all of the studies and suggestions of mid-1960, was to accelerate and improve the reconnaissance satellite effort--"a periodic phenomena since the fall of 1957," as he characterized it. In a note to Dr. Charyk early in October he remarked of the "'money is no object' exercises": "As a minor participant in these [recurrent] . . . flaps, I gradually learned the rules of the game and at the same time gained some perspective which I believe is relevant to the current situation."

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* The point of origin of the "technological surprise" philosophy remains uncertain. Unlike the notion of developing a reconnaissance system which would remain available in case the official Samos program had to be cancelled for some political reason, "technological surprise" was little discussed in contemporary documents. Nevertheless, it was almost certainly considered in the October-December 1960 period when the outlines of SAFSP organization and objectives were taking shape. It certainly was a factor in the more gradual program evolution of early 1961. It depended, of course, on the premise that operation of some reconnaissance satellite would be accepted--or not opposed--by the Soviet Union, but that capability would be concealed.[9]

Realistically, Greer concluded that the simplest, most direct way to get results was to "pump more money into the system," although that technique invoked the inherent risk that "one may pay a high price for a small gain." Greer added, "The commodity that makes Sammy run at my end of the business is money. The effect of all the words I use to contractors is dwarfed into insignificance when compared to the effect on them of cutting off money or adding money. This gets their attention and is the fundamental yardstick the contractor uses to determine how serious one is on a given issue."

His solution was to try for the least expensive program that could be based against approved schedules, or the best schedules that could be arranged in the face of a fixed and limited budget. His preference, he told Dr. Charyk, was to "loosen the purse strings by a significant amount [and] . . . put more emphasis on early performance and less on economy."[10]

The second major objective, apart from straightforward program acceleration, was to conduct a covert program. The Air Force was accustomed to rapid changes of direction in programs and could cope with them but had little expertise in covert research and development. The real difference between a "covert" and a highly classified program was not at all well understood, largely because the Air Force had in the past remained on the periphery of covert activity. "Black" aspects of Genetrix, the U-2, Corona and similar programs in which the Air Force had to some degree been involved had been entirely managed by the Central Intelligence Agency--although CIA drew freely on such Air Force technical talent, resources, equipment, and skilled personnel as were available. Locating and extracting information on how to conduct a covert program was a delicate operation. A minor blunder, a slightly indiscreet query, would compromise the effort because the mere expression of interest suggested that the questioner might be trying to set up a covert activity in his own area.

Some of the trappings of undercover work seemed unnecessarily melodramatic. The Air Force security system tended to operate much like an exclusive club, rights of admission being determined by possession of a top secret clearance, sufficiently high rank, and generous interpretation of the classic "need to know" rule. The original Atlas program was a case in point. The most that could be expected of security within the Air Force was to obscure details of progress or program status; "normal" Air Force security had never succeeded in concealing the existence of a program or its goals. Although the "club" outlook and the irrepressible habit of making presentations at every opportunity contributed to the general laxness of security within the

Air Force, the chief offender was the system of required reports--chiefly financial. Generations of military leaders had grown up in the conviction that an attempt to conceal or obscure the details of financial transactions and contracts was immoral. It was standard practice to focus a harsh white light on every activity that featured the exchange of government money. Safeguards were so elaborate that there seemed no conceivable way of letting contracts without becoming enmeshed in the intricate formalities of Air Materiel Command procedures--in which hundreds of people were necessarily involved.

General Greer early concluded that the most difficult task he faced was keeping his financial dealings out of foreordained channels. If it became known that his organization had quietly sponsored multi-million-dollar work on cameras and satellites, the implications would at once be obvious to every clerk and junior officer who processed financial records. But after considering the prospect, Greer concluded, perhaps cynically, that the Samos program director could do quite a lot of covert purchasing and contracting without alerting the materiel command, [redacted]

[redacted]

Many problems of operating a covert program were familiar to the original Corona team but new to Samos. A complete break with tradition, custom, and established habit certainly would be needed if Samos was to include a covert aspect. It had been General Greer's observation that in the conventional military organization every officer exposed to a closely held piece of information immediately experienced an overwhelming compulsion to inform his immediate superior, while all commanders reacted by deciding that it was absolutely essential to brief certain "key members" of their staffs.* The inevitable result was early and complete loss of security, followed by powerful pressure to maneuver the entire system back into "normal channels." Greer was particularly concerned by the reflex tendency of military personnel to retreat into ordained procurement channels, noting ruefully that "when your contracting, financing, and comptrolling are 'normal' it matters little that your command and communications are direct. Sooner or later the powerful pull of the financial management process will align the rest of the management machinery with itself."[11]

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* Undersecretary Charyk ultimately had to forbid both General Anderson and General Schriever to pass knowledge of covert Samos programs downward in their headquarters; General Greer had to flatly forbid one procurement officer to brief an unknowing superior; and early in 1961 several members of the ARDC staff had to be "debriefed" of information they had acquired rather casually. The whole had overtones of Poe's "Imp of the Perverse," the tale of a perfect and unsuspected murder. Poe imbued the murderer with a compelling need to confide in somebody--anybody. He could not resist. General Greer hoped for a happier ending.

Appreciating that "developing a capability for certain programs is a technique and . . . almost an end in itself,"[12] Greer set out to obtain the basic ingredients of authority needed to perform his assignment. The difficulty was that nobody knew precisely what was required in th procurement realm. First steps, therefore, were in the direction of simplifying contracting procedures so that the basic Samos effort could be more expeditiously handled. In October, General Greer succeeded in having Major General T. P. Gerrity, the Ballistic Missile Center commander, invested with authority to approve reconnaissance satellite contracts to a limit of [redacted] subject only to secretarial-level determinations and findings. "Open" procurement of such items as boosters and launch stand modifications received concurrent authorization.[13]

In the matter of covert contracting it was early apparent that the only way to circumvent all the requirements for reports and

[redacted]

[redacted]

[redacted]

[redacted]

Since one of the major goals of the Samos reorganization had been to accelerate the entire process of satellite reconnaissance, it was in some respects as important to remove obstacles to rapid "open" contracting as to invent techniques for covert procurements. Moreover, the National Security Council decision to segregate Samos from the remainder of Air Force research and development, together with subsequent directives that cut across established channels of command and communication, provided an excellent means of occluding the whole of the Samos project. The October 1960 action that gave [redacted] major commands were formally notified of these new facts of life and of the special status to be accorded Samos thereafter. The notification boldly stated that neither review and approval authority nor the right to program briefings was implicit at any level between the program director (Greer) and the secretary's office (Charyk). At the same time, General Greer was formally assigned to the secretary's office with additional duty as BMD vice commander. For nearly two months, since the time of his original selection, Greer had legally been a "primary duty" vice commander and thus subject to the orders of both the BMD and the ARDC commanders.[15]

Basic policy questions involving what aspects of the program should be emphasized, how the covert activities were to be approached, and how the new techniques of program security were to be activated were largely resolved in October, November, and December 1960. A key indicator was Dr. Charyk's ruling that no public announcement of the pending E-6 source selection would be made either by the Air Force or by the selected contractor.*

A new public information plan being constructed for Samos was to be based on the thesis that "it is no longer in the national interest to release detailed information on the SAMOS project." Basics of the arrangement were made known to BMD on 4 November--including the caution that there was to be no public announcement of the new policy. If necessary, however, BMD was authorized to answer questions about the E-6 competition by stating that Eastman had been given a contract to develop "'photographic' components" and Martin a contract to develop "a recovery capsule."[16]

In point of fact, the skeletal information that reached the Ballistic Missile Division contained little more than instructions to award contracts to Eastman (photographic subsystem) and Martin (applied research in the area of maneuverable, lifting body reentry vehicles) and to expand existent Aerospace Corporation contracts to cover systems engineering and technical direction of the E-6 development.[17]

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* Queries concerning the outcome of the source selection process were to be directed to the secretary and answers were to be based on the proposition that anything which could be successfully denied would be. Thus, since the fact that an E-6 "competition" was in process had been widely circulated within the aerospace industry, the question "Has an E-6 award been made?" was to be answered merely, "Yes."

During the first week of November 1960 a second set of key decisions emerged from a series of Pentagon meetings. Undersecretary Charyk and General Greer discussed the available technical options in greater detail and agreed to drop further consideration of the [redacted] approach. They reconfirmed their determination to conduct a covert reconnaissance operation, nonetheless. Charyk approved further study of the concept of encasing a camera in an orbiting missile nose cone and using the "warning system test program"* as a cover for reconnaissance flights.[18]

A new and highly significant innovation of the early November meetings was the [redacted] Charyk agreed with General Greer's suggestion that [redacted] developed a suitable ballistic reentry vehicle. By keeping the physical and environmental limitations of [redacted] compatible with one another, it seemed possible to develop and test

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* [redacted] had been named [redacted] and the [redacted]

[redacted] without any outward indication that such a program existed. The institution of rigid security controls over the whole of the Samos operation would greatly enhance the possibility that the scope of the total program could be entirely hidden. Thus "technological surprise" became a goal of the new Samos program.

Before the plan could become effective, however, program managers had to dispose of the widely dispersed evidence [redacted] camera development existed. As had been true of "Project II" in early 1958, and of Carousel in 1959,* the proposed [redacted] development program was so widely known that it would be necessary to invent and circulate a palatable reason for cancelling an essentially reasonable approach to satellite reconnaissance. Project personnel achieved that end by having BMD terminate the Eastman study contract fo[redacted]

[redacted]

Simultaneously, the Samos office drew up the first of its "black" contracts, authorizing Eastman to continue the development as a covert effort.

[redacted]

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* See Volume I for details.

[redacted]

By the morning of 7 November 1960, General Greer had briefed [redacted] time compatible with attainment of the desired objectives. Lockheed, which ultimately became involved by virtue of the decision to use Agena as a stage in the total system, essentially did no more than supply a semi-standard vehicle. [redacted] Eastman chiefly relied [redacted] operated under the same extremely rigid "need to know" ground rules as the Samos office.[20]

[redacted] of the same period generally established a philosophy for SAFSP activity but fell short of constituting a policy. In some respects, specifications of the program office transformed philosophy into policy,* but in other regimes more formal action seemed required.

Although the changed circumstances of the Samos program should have been obvious to all of the Air Force by October, there still were indications that in some quarters the passing of the old order either was not understood or was not accepted. Late that month, Air Force headquarters advised the Air Materiel Command that it would be well to plan for operational-use logistic support of Samos using the operational dates listed in the "latest" program guides. Some three weeks later, the Strategic Air Command informed ARDC that the "requirement" to turn both Samos and Midas over to operational commands at the earliest possible moment was "still valid and must be recognized." Shortly thereafter, ARDC issued an operations order (which had been in preparation since late September) that at least implied, if it did not specifically define, a considerable role for the research and development command in the conduct of the Samos program.[22]

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* [redacted]

General Greer's office, following a post-publication review of the operations order, decided that it was generally in concert with earlier expressions of project objectives. Less charitably, some of the project staff members characterized it as "harmless," even though it implied an unwarranted element of ARDC project authority.[23] The Air Staff and Strategic Air Command viewpoints were another matter, so on 6 December Undersecretary Charyk sent a pair of memoranda to the Air Force Chief of Staff which restated the objectives and operating principles of the Samos effort.

The first of the papers was classified secret but was "white" and was obviously intended for general circulation among those whose security clearances and positions made them members of the "club." It set forth several key theorems: (1) Samos "should be regarded as an R&D program aimed at the exploitation of various promising reconnaissance techniques"; (2) the program would nonetheless be oriented toward obtaining operationally useful intelligence; and (3) the "nature and character" of the eventual operational system were "completely conditioned upon the success of the methods which will be exploited in the R&D program." "Accordingly," added Charyk, "effective operational planning can not be accomplished at this time."

Dr. Charyk observed that major resources were still being expended in efforts having "little or no connection with the new direction of the R&D program" (a certain reference to continued attempts to retain Subsystem I) and that there was a "startling lack of knowledge and familiarity with the reoriented program." He noted with some asperity that many "unfortunate remarks" in public, repeated in the press, were serving to make achievement of program goals most difficult and proceeded to specify policies that would reduce the incidence of such occurrences: (1) Samos was not to be included in the "normal" program documentation published under 375-series regulations; (2) as necessary, General Curtin's office (SAFMS) would provide entries for the Chief of Staff's Policy Book for legislative matters; (3) the Weapons Board was not to "monitor" the Samos program and "no reviews or analyses should be undertaken by the various panels, boards, and committees"; (4) operating-command reconnaissance requirements would be reviewed as received; and (5) the Samos Working Group should be dissolved.*

In a separate note to General White (sent the same day, but marked "Special Handling" to insure that it would reach only [redacted] cleared personnel), Charyk set forth for the first time the basic philosophy behind the new Samos program. He called attention to the fact that "very serious pressures" would be directed toward a fully operational reconnaissance system and that it was essential, therefore, to "maximize the reconnaissance take at the earliest possible date and to attempt to obtain such information in as low key a fashion as possible." Since the greatest chance of program success seemed to lie in conducting Samos as a long-term research and development effort and there were compelling national policy reasons for avoiding any association with a military operational command "such as SAC," it was desirable to establish a "combination research, development, and operational program conducted under cover of research and development. . . ."

Said Dr. Charyk, ". . . it is not contemplated that there will be an acknowledged or normal operational phase within the near future."

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* Dr. Charyk's use of the term "wasted effort" in connection with the abolished reports, panels, boards, and "working groups" clearly defined his opinions on the worth of such activity to the program.

He added, "the policies, actions, and procedures necessary to support this configuration of the project are completely different from normal policies, actions and procedures and will certainly tend to produce misunderstanding and criticism within normal organizational channels." He conceded also that the problem was further complicated by the fact that the "full story" could not be given to all who were affected, adding, "In fact, it must be held most closely if it is to be effective at all." When progress was sufficient and national policy permitted a change, a transition to "a normal operational program" would be scheduled, the undersecretary suggested. But, "in the meantime, the program will include all essential elements to meet the reconnaissance requirements and to exploit the data so obtained."[24]

Though phrased with considerable finesse and in terms that probably would not cause the "in channels" Air Force to rise in revolt, Charyk's policy statement nonetheless represented a total rejection of all operational command claims to deployable systems and of all research and development command claims to management authority. There was no real doubt that he intended to streamline the management process by eliminating ARDC influence (and procedures), to give the Samos program the nominal character of an extended research and development effort, and to make the Samos project an operational organization which would essentially treat the Strategic Air Command as merely another user of acquired data. An uninhibited conversation between Greer and Charyk later in December made those propositions explicit.[25]

Thinking through the implications of the several policy papers that had emerged since the National Security Council decision of August, General Greer concluded in December that his real job was to "get pictures . . . in such a manner as not to precipitate a U-2 crisis in which the U.S. might be constrained to discontinue SAMOS," and to insure the availability of systems which could covertly obtain needed photographs should even "low key" reconnaissance operations become impossible. His immediate task, then, was to create a real ability to operate a covert program, and his chief difficulty of the moment was that "the military system for contracting and for dispersing money are very cleverly designed to frustrate a covert program."[26]

The elements of general policy under which SAFSP was to operate had been defined in February and appropriately circulated by the end of May 1961. On 29 May, a classified Headquarters USAF Office Instruction formally restated, for the benefit of the Air Force at large, the program rationale that had been adopted. For practical purposes, it was a formalization of Undersecretary Charyk's December

1960 memorandum to General White, neither expanding nor enlarging the instructions there defined.[27] Considerably more important was a 3 April "Satellite Reconnaissance Plan" which, though closely held, defined in considerable detail and in formal fashion the actual "policies, procedures, and actions to be applied . . . in order to achieve the . . . objectives of the national satellite reconnaissance program."

Those objectives were to enhance and protect the probability of "adequate and timely data collection" without "inviting possible political counteraction, " and to create a lasting ability to acquire reconnaissance information" in the event that circumstances should force limitations, reduction, or even elimination of overt flights."

The situation that prompted the covert effort was essentially that the overt objective of creating an American satellite reconnaissance system had been widely publicized, that regular flights ("overt and acknowledged") with military objectives were scheduled to begin in the near future, and that any indication of program success might provoke both political counteraction and a military response from the Soviet Union. Neither was wanted.

The plan specified that:

> As a firm basic policy, there will be no "operational" overt satellite reconnaissance or any association of the program with an operational command for an indefinite time, and the overt satellite reconnaissance program will be brought to a fully operational status under cover of

> research and development, and operated indefinitely under this cover. The policy expressed in the 6 December 1960 Top Secret memorandum from the Undersecretary of the Air Force to the Chief of Staff, entitled "Basic Policy Concerning Samos," will continue for the indefinite future.

Reflecting the urgency of technical efforts based on the political environment, the policy document contained a forthright statement of the need for more intensive control of project security and for the maintenance of "a viable covert effort which has the feasible capability of being sustained indefinitely after cancellation of the overt effort."

Significantly, the objective of tightened security was to eliminate virtually all public references to military space programs and specifically to prohibit public disclosure of the flight test objectives or results of satellite reconnaissance. Within such an environment it seemed possible to culture a covert effort ". . . sustainable indefinitely in the wake of a forced public cancellation of the overt reconnaissance program, and which can meet all principal intelligence objectives of the overt program." To that end, it was necessary to conduct the satellite reconnaissance aspect of the total Air Force military space program so effectively that no indicators of the status of the overt program would surface in public. The covert program, of course, would be still more obscure--hidden even from many of those nominally cognizant of the extent and progress of the overt effort.[28]

Within six months of the decision to shift Samos management to a higher level and to accelerate the pace of technical development, the basic program had been completely overhauled. Quite apart from the important new directions technology was taking, program objectives had altered so significantly that the new program bore no resemblance to anything that had preceded it in Air Force experience. The mass of detailed changes somewhat obscured but could not conceal the fact that what had been created was a highly specialized project organization with unprecedented authority, a capability to respond rapidly both to new requirements and to direction from higher authority, and a set of goals that would have been technologically infeasible in a pre-1960 environment. The concentration in a single relatively small organization of very sweeping engineering and procurement responsibility, exemplary technical and managerial talents, and adequate financial resources constituted a remarkable concession to the urgency of the satellite reconnaissance effort. The assignment to such an organization of responsibility for clandestine development of reconnaissance systems was highly unusual; to make that organization ultimately responsible for the operation as well as the development of a major weapon marked a radical break with the past. Yet in a period of about six months all of these innovations had been conceived, approved, and applied.

The generation of a policy did not immediately solve all policy problems, nor did the definition of program goals eliminate all program uncertainties. The relationship between the clandestine Corona effort and the part-concealed, part-clandestine activity being conducted by General Greer's establishment remained somewhat uncertain, even though on 20 September 1960 Charyk had directed that Air Force participation in Corona should be handled within the Samos management structure. (Argon, the Army-originated covert mapping satellite program, was the subject of an identical order.) Colonel Paul E. Worthman, Air Force Corona chief, found himself in a somewhat awkward position. Like his predecessor, Colonel Sheppard, Worthman had in many respects occupied a special-category management position, exercising virtually all important Air Force authority in Corona but having no real Air Force chain of command either above or below him. His contact point in the Pentagon had been the Advanced Technology Office of the Air Staff, an organization absorbed by General Curtin in September 1960, but for practical purposes he had originated program proposals (including proposed schedules, payloads, and launch dates, for instance) without much concern for coordination with or concurrence by other Air Force echelons. Corona requirements had dominated the "Discoverer" program and pretense to the contrary was specious.

The new arrangement brought about fewer immediate changes than might have been anticipated. Greer and Worthman first discussed the essentials of their relationship on 20 October, shortly after Colonel Worthman learned that the general was to be the West Coast "focal point" for Corona matters. Typically, Greer told Worthman he wanted no changes in the existent operational and organizational arrangements, that Worthman would continue as the Air Force Corona (and Argon) director, and that there was no need to depart from established communication channels. (Thus Worthman continued to deal with the CIA and Corona contractors by means of a special crypto teletype network created for that purpose. Such communication channels were not open to the Air Force, nor were copies of Corona correspondence normally furnished to members of Greer's staff.)[29]

Although an entirely comfortable working arrangement resulted on the West Coast, there was for the moment virtually no integration of activity or personnel there. No open antagonism was apparent, but the divergence of interest between Samos and Corona suggested that dangerous friction could have developed had the personalities of Greer and Worthman been different. At the policy level, particularly as it concerned security, differences in viewpoint resulted as much from the experience of the Corona people and the relative inexperience of the Samos group in covert activity as from any other factor. With justification, Worthman's group took considerable pride in Corona program achievements and in the fact that notwithstanding all the discouragements of early years, Corona had returned and was continuing to return useful intelligence. Corona was performing precisely as the Samos program was not intended to perform, and the Corona people tended to resist innovations that might change their circumstances unfavorably.

Members of the Samos organization, engaged in an enterprise tenfold larger and more costly than Corona, and convinced that the highly sophisticated E-6 would shortly displace the theoretically less capable Corona system, tended to be a bit superior about the older program. There was also the fact that relatively few of the Samos people were cognizant of Corona achievements, while most of the local Corona team members knew [redacted] were familiar with E-5 and E-6 details. (Even though they were aware [redacted] of the principles of covert operation, [redacted] personnel who were subsequently given access to Corona program details frequently expressed astonishment at the existence of Corona.) Most of the Corona people were hearty supporters of a stereo version (Mural) then beginning development and were enthusiastic about the prospects of the C''' (pronounced cee-triple-prime) version of Corona nearing flight test. If the Samos people were confident that E-6 would make Corona obsolete, the Corona team was equally certain that improvements like C''' and Mural had a chance of equaling or surpassing anticipated Samos achievements--and at lesser cost and sooner than the Samos development schedule would permit.

In the light of such circumstances, it was remarkable that the Corona and Samos groups on the West Coast got along as well as they did. It was not that each group had uncritical confidence in the other's good intentions, or good faith. In some instances a consequent lack of full and free communication of ideas, both technical and procedural, undoubtedly hampered one or both of the still separate efforts. But on the whole the relationship was effective; damage was slight.*

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* This assessment is based on a series of discussions with individuals who were engaged in both Corona and Samos programs, at all levels, during the period August 1960-December 1961. Although the hallowed traditions of historiography require a full statement of sources, I feel no compulsion to specify who said precisely what about the early relationships between the "Greer group" and the "Worthman group." The terms themselves are misleading, since General Greer and Colonel Worthman had high regard for one another's talents, and the members of the two "groups" were not so much divided by different loyalties as convinced of the superiority of their own programs. It has been suggested that a notation of latent or blatant conflict between two groups of Air Force people is inappropriate to an account of this nature. For my part, I think it remarkable that two groups with potentially catastrophic differences worked so effectively together and, in time, quietly blended. The viciousness of some intra-Air Force "differences of opinion" is legendary, and the consequences of such

Contacts at the next higher level of organization were not always so peaceable. Dr. Charyk early assumed that Corona should come under his control, as part of the total satellite reconnaissance

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"disputes" have occasionally been deadly. There is no better indication of the dedication, intelligence, and general good sense of Samos and Corona program participants than the overall effectiveness of their relationship during 1961. It improved later, when organizational differences were resolved, but that was inevitable in the nature of things.

One aspect of Corona-Samos program relationships that has not been treated here is the role of Central Intelligence Agency participants in Corona. It was not, in fact, a significant problem in 1960 and 1961, and it remained a relatively high-level problem, with little impact on the West Coast program office structures, until 1963. Again, that may have been largely a matter of personalities. Richard Bissell, CIA's deputy director, and J. V. Charyk, head of the Department of Defense satellite reconnaissance program as Undersecretary of the Air Force, had an effective working relationship that more than offset the organizational imperatives their subordinates usually experienced. Perhaps as important, in 1960 and 1961 the Samos and the Corona working groups were comparatively small and were mostly composed of individuals with long and generally happy experience in interactive Air Force-CIA affairs. Greer, Ritland, Worthman, and Sheppard were veterans of earlier cooperative enterprises ranging from Genetrix to the U-2; Bissell and his closest associates (Eugene Kiefer, for instance) were similarly experienced. Finally, Bissell and Charyk looked on satellite reconnaissance as a national activity rather than as the unique province of one agency or another. The lust of CIA and Air Force program participants for one another's assigned programs did not become an important consideration in the national reconnaissance effort until Charyk and Bissell had left office. (RP) effort, and began by exercising as much authority as he could summon. He did so with the implied approval of the CIA's deputy director, Bissell. The peculiar chain of command for Discoverer-Corona program decisions occasioned the first friction. Habitually, Corona launch schedules--and thus Discoverer schedules and payload allocations--were determined by the Corona group at BMD based on advice from CIA. Intelligence requirements were the basic justification for establishment and alteration of such schedules. During the long drought, when the first 12 Discoverer flights had constituted one continuing disappointment, decisions had been almost automatic. They were originated within the Corona program, surfaced as recommendations from the Discoverer program office, and forwarded from BMD to ARDC headquarters for rubber-stamp approval. Theoretically, ARDC headquarters was the deciding authority, with the Air Staff exercising a veto. Once the Corona flights began returning "take," automatic scheduling disappeared and the question of who actually was the deciding authority assumed some importance. In October 1960, General Schriever decided that the long-delayed biomedical capsule for Discoverer ("the monkey capsule") should finally be flown. He instructed General Ritland, at BMD, to construct an appropriate schedule and General Ritland, with some trepidation, complied. When the altered schedule reached Undersecretary Charyk, he reacted strongly. He believed that biomedical experiments leading to manned orbital flight were the responsibility of the National Aeronautics and Space Administration (NASA); the Air Force had been told to get out of the "man-in-space" business. He promptly ordered that no future schedule or program modifications be introduced without his prior and express approval.

Although Charyk's dictum was actually prompted by a new Air Force attempt to inflate its man-in-space role, it had the effect of serving notice on the CIA that henceforth Charyk's organization proposed to decide what Corona payloads flew, and when. By implication, it also suggested that Dr. Charyk's organization had a deciding voice in technical questions, a prerogative that CIA treasured. To resolve such questions, though without a specific preliminary statement of issues, a meeting was called in Charyk's office for 3 November 1960.

Richard Bissell, CIA godfather and patron saint of the Corona program, was actually the only CIA official competent to establish his agency's position. He was unable to attend the meeting, leaving the discussion to middle-management representatives from the West Coast Corona office, CIA headquarters, and Charyk's staff.

In the discussions that followed, Dr. Charyk made it clear that he considered his charter to include a considerable authority over

Corona as well as Samos. He conceded the need for continued direct contacts between the CIA and the Corona office at BMD but insisted that henceforth all changes in schedules, dollars, payloads, and technical features be coordinated with him. The discussions also made it apparent that the CIA middle management had no intention of abdicating its authority for Corona activity, in which the agency had invested nearly four years and [redacted] dollars, although Bissell's absence prevented any direct confrontation on such issues.

Such conversations continued through November and into December without producing any ground for general agreement. Charyk indicated, in December, that he favored an integrated cover plan for Corona and Samos (particularly [redacted] although that effort still was in its infancy). He questioned whether a cover based on the expressed intention of eventually firing one biomedical capsule into orbit was adequate for all of Corona. What he failed to recognize--perhaps because even the Corona people still had no more than an instinctive feel for the situation--was that after 12 less-than-successful firings the program was its own excuse for continuance. Each program failure justified a whole succession of later trials for which no payload specifications need be revealed.

The discussions of November and December 1960 made it reasonably clear that Charyk, and in some degree virtually all of the Samos-oriented group, adhered to the earlier unchallenged assumption that Corona was a gap-fill reconnaissance system with a limited future. Confidently expecting the E-5 and E-6 programs to produce results far surpassing the capacity of Corona, Charyk persistently asked CIA representatives to specify a completion date for the Corona effort. No answers were forthcoming--which induced some members of the Samos group to conclude that the Corona people were erecting a rival effort which they intended to operate independent of the "unified" satellite reconnaissance program.[30]

The cross flow of proposals and anti-proposals established an atmosphere for continued operation of both the Samos and Corona programs but did nothing to resolve the matter of basic Air Force authority in Corona. Although he received verbal advice from time to time, General Greer never was given a definition of his authority over Corona. So long as Richard Bissell remained the chief CIA authority on that program and Colonel Paul Worthman remained its program director, that circumstance was not important. For a time, certainly through all of 1961, the basic problems of the Thor, the Agena, or the payload independently remained important enough to obscure concern for problems arising through the interfaces of those elements. Later, when the basic elements of the total system were working reasonably well, it became apparent that faulty interaction between the payload and those system portions obtained through Air Force channels was serving to inhibit the operational utility of the total system. In such an environment, a central authority was needed to resolve issues affecting various of the integrals of Corona--and none existed.[31]

The impulse which had led, through devious channels, to the creation of an SAFSP organization in August 1960, had by early 1961 caused that organization to have a shape and content largely undreamed of six months earlier. In early 1961, the reconnaissance satellite program consisted of Corona, with various pending improvements which would make it a rival of some aspects of Samos, and a basic Samos program which had taken on unique characteristics of its own. Both readout photography and readout ferret programs still survived, as the E-1, E-2, and F-1, F-2. The E-5 of 1959 vintage continued development, an E-6 more nearly responsive to current intelligence requirements had begun development, [redacted] was progressing toward flight test at a somewhat slower pace. Additionally, in the early months of 1961, Undersecretary Charyk [redacted] [redacted] essentially creating one new program in the process, and over a span of months he directed the revitalization of a mapping satellite project (E-4) which, though it had ancient antecedents, was essentially a rival to the existent Argon mapping satellite program.*

Of these various actions and their consequences, the establishment of a covert satellite program, [redacted] was more important than most others. With [redacted] came into being a tightly contained procurement and program management capability that had no real precedent in the Air Force. Security requirements originating in the President's desire to avoid any implication of military operations in space became so tight that the transition from "extremely secure" to "clandestine" and thence to "covert" was in some sense inevitable. The political vulnerability of the widely publicized [redacted] even more important than would normally have been true, though the very remarkable performance promise [redacted] system was in some respects a sufficient justification for emphasizing that program.

The SAFSP organization possessed some unique advantages that were obvious only to those familiar with its workings. First and foremost, by virtue of Dr. Charyk's insistence on directly managing program activity, it had short, quick-reaction lines of communication and decision. Exclusion from reporting requirements

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[*] These individual programs are treated separately, in following chapters.

imposed on other Air Force projects meant relief from some of the most frustrating and time-consuming aspects of technical development. Security was sufficiently tight to permit complete exclusion of most "auditors" and "reviewers" who, in other programs, had the authority to require review, and to require revision, but who had no authority to approve. Additionally, because it possessed mission unity, the Samos project could reprogram funds to considerable advantage without the difficulties that attended such a process in the "normal" Air Force. Although the ultimate span of Charyk's authority had yet to be clearly defined--and was to be an issue of some proportions for another two years--for practical purposes the Samos project was able to submit recommendations directly to an agent with authority to act.

Certain problems remained. The relationship of *Corona* and its variants to Samos and to the balance of the satellite reconnaissance program had to be defined and, having been defined, had to be reduced to management essentials. In the same sense, it seemed inevitable that the abundance of individual approaches within the complete satellite reconnaissance program would lead, in time, to a more compact total program. (Counting *Corona* and *Mural* separately, as was then the practice by early 1961, there were two readout and five recoverable-capsule reconnaissance satellites in development, plus two mapping systems and two ferret systems.) Progress--or its absence--in individual programs seemed the most obvious criterion for determining which should be aborted and which continued. Even by early 1961 it was apparent that available funds would not support everything then programmed, though the total of resources available for satellite reconnaissance had increased substantially in the preceding year.

NOTES ON SOURCES

1. Ltr, A.B. Simmons, EK, to J.V. Charyk, SAFUS, approx 20 Jun 60, no subj; ltr, Simmons to Charyk, 22 Jul 60, no subj, both in Charyk files (in SAFSS); (both letters bear CIA cover-address indicators); memo for record, BrigGen R.D. Curtin , 10 Aug 60, subj: [redacted] ARDC, 3 Aug 60, in SP-3 files.

2. Memo for record, Curtin, 10 Aug 60.

3. TWX AFDSD 76820, USAF to ARDC, 13 Aug 60, in SAFSP files.

4. Ltr, [redacted] to CG BMD (sic), attn Maj E.J. Conway, 13 Aug 60, no subj; TWX WDRSP-16-8-1, BMD to ARDC, 16 Aug 60, both in SAFSP-3 files.

5. Memo, LtCol L.C. Jochim, Samos Dir, for the Record, 12 Aug 60, no subj; Ltr, Col W.G. King, Dir/Samos, to AMC-BMC, 15 Aug 60, subj: Sole Source Justification, both in SAFSP-3 files.

6. Dev Plan, "Recoverable Photographic Reconnaissance Satellite," prep by STL for BMD, Aug 60, in SAFSP files; interview, LtCol John Pietz, SAFSP, by R.L. Perry, 29 Oct 62.

7. Memo for record, BrigGen R.E. Greer, Dir/SP, 20 Sep 60, subj: SAMOS Program Meeting with SAFUS, in SP-3 files; draft memo, Greer to BrigGen R.D. Curtin, SAFMS, 6 Oct 60, no subj, same file. Though the 6 Oct memo was not sent to Curtin, it was used as a basis for SAFSP policy determinations for the next several months (interview, Col J.W. Ruebel, SP-3, by R.L. Perry, Hist Div, 12 Dec 62.)

8. Interview, BrigGen J.W. Martin, SAFSS, by R.L. Perry, Hist Div, 8 Nov 63; presentation notes dtd Aug 60, in Charyk files, SAFSS.

9. Interview, LtCol John Pietz, SP-3, by R.L. Perry, 23 Jul 63; interview, Col J.W. Ruebel, SP-3, by Perry, 6 June 63.

10. Ltr, BrigGen R.E. Greer, Dir/SP, to SAFUS, 4 Oct 60, subj: Acceleration of Reconnaissance Program, in Ofc Miss and Sat Sys files: Gen.

11. Memo, Greer for Curtin (not sent), 6 Oct 60; interview, Greer by Perry, 12 Dec 62.

12. Greer notebooks, entry for 20 Oct 60.

13. Ltr, BrigGen R.E. Greer, Dir/SP, to Ofc Miss and Sat Sys, 24 Jan 61, subj: Contract Administration, inclosing memo for record, prep by Greer and witnessed by Col J.W. Ruebel, Spec Asst to Dir/SP, 16 Jan 61, subj: Contract Disbursing, in SAFSP files: TWX, SAFSP-TS-60-3, SAFSP to SAFMS, 2 Oct 60; TWX SAFMS-Sys Eng-60-6, SAFMS to SAFSP, 17 Oct 60; Warrant of Contracting Ofcr, 5 Oct 60, approved by LtGen W.F. McKee, V/Cmdr AMC, all in SAFSP (SP-3) files.

14. Memo, D.C. Sharp, SAF, to Dir/Samos Proj, 5 Jan 61, subj: Delegation of Authority; memo for record, prep by BrigGen R.E. Greer, Dir/Samos Proj, 14 Feb 61, no subj (also signed by Col J.L. Martin, D/Dir/Ofc Miss and Sat Sys); ltr, Max Golden, DAF Gen Counsel, to Greer, 15 Feb 61, no subj, all in SP-3 files, Policy.

15. DAF SO A-1790, 27 Sep 60, confirming verbal orders of SAF of 6 Sep 60; DAF SO A-1832, 6 Oct 60; ltr, Col R.R. Rowland, Secy/Air Staff, to all Maj Cmds, 14 Oct 60, subj: Missile and Satellite Systems, all in SAFSP files.

16. Memo for record, prep by Col P.A. Heran, Dir/E-6 proj, 8 Nov 60, subj: Trip Report to Hq USAF (2-4 Nov 60), in SAFSP files. TWX, SAFMS-99153, SAFUS to BMD, 4 Nov 60, in Ritland files; interview, Col P.A. Heran, SAFSP, by R.L. Perry, 20 Dec 62.

17. TWX, SAFMS 99153, 4 Nov 60.

18. Memo for record, Heran, 8 Nov 60; notes taken by BrigGen R.E. Greer, Dir/SAMOS Proj, 3 & 4 Nov 60, in personal notebook (hereafter cited as Greer Notebook); Heran interview, 20 Dec 62; Greer interview, 20 Dec 62; TWX SAFMS-Sys Eng 60-6, 17 Oct 60.

19. Memo for record, Heran, 8 Nov 60; Greer Notebook, 2, 3, & 5 Nov 60; TWX SAFMS 99533, SAFMS to BMD and WADD, 7 Nov 60; Pietz interview, 12 Dec 62; memo for record, LtCol J.S. Seay, SAFSP, 7 Dec 60, subj: Visit to SAF (US) on 10 Nov 1960, all in SAFSP files.

20. Greer Notebook, 6-9 Nov 60; Pietz interview, 12 Dec 62; interview, Col J.W. Ruebel, Spec Asst to Dir/SAFSP, by R.L. Perry, 5 Dec 62; Greer interview, 20 Dec 62.

21. DAF SO E-2356, 23 Nov 60; Pietz interview, 26 Dec 62.

22. TWX AFMPP-WS-2-96055, USAF to AMC, 24 Oct 60, in SAFMS files, Samos Gen '60; TWX DPL 3416, SAC to ARDC/BMD, 17 Nov 60, in SAFMS Telecon files, Oct-Nov 60; ARDC Ops Order 60-1, 23 Nov 60, and ltr, Col R.E. Soper, Asst DCS/P&O, to MajGen O. J. Ritland, Cmdr BMD, 7 Dec 60, subj: SAMOS Operations Order, in Ritland files. Although General Greer reviewed the Operations Order with Col Soper in advance of its submission to ARDC headquarters, final revision apparently was completed in that headquarters without further reference either to BMD or to SAFSP. Col Soper who headed the "preparation team" was unaware of SAFSP's real (i.e., covert) program objectives.

23. TWX SAFSP-DP-6-12-3, SAFSP to SAFMS, 8 Dec 60, in SAFMS files, Samos Gen.

24. Memos (2), J.V. Charyk, SAFUS, to C/S USAF, 6 Dec 60, subj: Basic Policy Concerning SAMOS in SAFSP files. One memo is Secret, the other Top Secret - Special Handling. The Secret memo received relatively wide circulation; the other, virtually none.

25. Greer Notebook, 27 Dec 60.

26. Memo (not sent), Brig Gen R.E. Greer, Dir/Samos Proj, to SAFUS, approx 28 Dec 60, subj: Progress Report SAMOS, in SAFSP file, Gen.

27. Hq USAF OI 25-5, 29 May 61, subj: Management, Basic Policy Concerning Samos, signed by MajGen R.M. Montgomery, Asst VCS. Although routinely filed in SAFMS, the OI somehow escaped dispatch to SAFSP; no copy could be located in the West Coast offices.

28. Rpt, Satellite Reconnaissance Plan, 3 Apr 61, prep in Hq USAF (SAFMS?), in SP-3 files, NRO.

29. Memo, J.V. Charyk, SAFUS, to BrigGen R.D. Curtin, SAFMS, 20 Sep 60, no subj, in SAFSS files; (there are two near-identical memos, one concerning Corona and the other Argon); memo for record, Col P.E. Worthman, 26 Oct 60, subj: CORONA-ARGON Focal Point, in Corona corresp, '58-60; interview, Worthman by R.L. Perry, Hist Div, 29 Apr, 3 May 63; interview, LtCol R.J. Ford, SP-3, by Perry, 9 Dec 63; interview, MajGen R.E. Greer, Dir/SP, by Perry, 9 Dec 63.

30. Memo for record, LtCol R.J. Ford, Corona Ofc, 30 Nov 60, subj: C&A Meeting, 3 Nov 60, in Dr. Charyk's Office, in Corona files; Meetings; memo for record, Ford, 13 Dec 60, subj: Telephone Conversation with Mr. John Parangosky, Corona files, corresp '58-60; TWX SAFUS 97384, personal J.V. Charyk, SAFUS, to MajGen O.J. Ritland, Cmdr BMD, 28 Oct 60, and msg 1461, Col P.E. Worthman, BMD, to R.M. Bissell, CIA, 28 Oct 60, both in Corona files.

31. Interview, MajGen R.E. Greer and LtCol R.J. Ford, SAFSP, by Perry, 9 Dec 63.

VII PHOTO-READOUT 1960-1963
(E-1, E-2, Subsystem I, and Tape)

When the Samos project finally became the direct responsibility of the Secretary of the Air Force, it included three photographic subsystems and one ground-based subsystem that stemmed directly from the original WS 117L program. Others were pending approval, but only the E-1 and E-2 readout systems and the E-5 recovery system were funded and in a hardware stage. Associated with the E-1 and E-2 was the ground-site complex of receiving, processing, storage and dissemination equipment that was known as Subsystem I (as J, K, I, . . .). Under the terms of the pre-1960 requirements, Subsystem I was also to be the key to the E-5 film handling and dissemination network, as then foreseen. Because it had originally been designed to complement E-1 and E-2, however, Subsystem I was generally considered to be associated with readout in the recovery-versus-readout controversy, and the system was also a focal point of the arguments over assigning operational responsibility for satellite reconnaissance to the Strategic Air Command. Subsystem I, operated by SAC, would give that command a dominant role in operating and controlling satellite reconnaissance.

As it happened, the period of Samos reorientation during the spring and summer of 1960 coincided with the climax of E-1 development, which had begun in 1956. Eastman delivered the first camera payload to Lockheed on 15 April and Lockheed completed its system test of the Agena-plus payload on 3 June. The payload included both an E-1 and an F-1 ferret subsystem. By September, the Agena-payload complex was mated with an Atlas booster at Point Arguello, and on 11 October it was launched to a considerable fanfare that included elaborate press conferences and a large audience of cameramen.

The launching went well enough to please photographers, but program people were less than happy. The satellite umbilical connection failed to release at launch and the hefty push of the Atlas booster tore away the nitrogen fill line--complete with couplings to the Agena--when the hoses reached their physical stretch limits. Although the Atlas operated perfectly and the separation of the Agena from the first-stage booster occurred as programmed, nitrogen had been boiling freely into the atmosphere through the entire boost period and the tanks were for practical purposes empty. Attitude stabilization depended on gas stabilization--and there was no gas. The Agena's engines ignited while the vehicle was improperly aligned for injection into orbit--and the flight was over. Investigation revealed that test base personnel had failed to install a half-inch assembly that should have joined the umbilical to the quick-disconnect fittings and that the nitrogen hoses were shorter than the lanyards which were supposed to pull away the quick-disconnect fittings. It was a design oversight that Dr. Charyk, for one, considered to be an incredible blunder.[1] He was not alone.

Quite apart from the fact that the absence of a tiny connector had meant the fruitless expenditure of at least $4.85 million for the booster, payload, and launch services,[2] the failure cost one of the three available E-1/F-1 vehicles and postponed, at least until January, receipt of the first readout data from orbit. Between January and August 1960, redirection of the Samos program had caused elimination of five of the original 11 scheduled readout flights; only three E-1/F-1 and three E-2 payloads had been authorized.[3] Even these were eliminated in early November, leaving only five readout payloads in the launch schedule.[4]

The rapid abstraction of readout tests was symptomatic of a widespread determination to get on with recovery programs that seemed much more promising. General Greer, who had urged and secured approval of the cancellation of the "extra" E-2's in a 2 November conversation with Undersecretary Charyk, considered the termination to be part of his "overall efforts" to bring technical goals into realistic alignment with available financial resources.

Lockheed was entirely in sympathy with his general goal. One officer from the Pentagon who visited the contractor's plant in November characterized the Lockheed attitude as "let's hurry and finish E-1 and E-2 and spend all our effort on recovery systems."[5] Those viewpoints, when added to the openly expressed conviction of the responsible project manager--Colonel W. G. King--that readout techniques were not truly practical, pointed toward a brief existence for the entire readout program.

If there were to be, at most, only five more camera-readout flights, any excuse for continuation of Subsystem I had vanished. The declining fortunes of that portion of the total Samos program were not entirely based on such factors, however. Nor was cost the chief motive, though the high price of development had been disturbing program managers for many months and the astronomical costs of installing operational subsystems had been a factor in anti-readout sentiment for more than a year.

Subsystem I had been the core of a proposed installation called the Intelligence Data Processing Center, planned for construction at Strategic Air Command headquarters virtually since the acceleration of the satellite reconnaissance program in early 1958. As was apparent even before the end of that year, however, there existed a considerable difference of opinion concerning the timing of that construction, the phasing of the turn-over to SAC, and the quality and quantity of the equipment to be installed. For the most part, policy officials in the Department of Defense were extremely sensitive to the implications of entrusting a satellite reconnaissance system entirely to a command with SAC's public image and private outlook. They favored, at most, creation of a research and development type installation that could, if technical and political considerations ever permitted, someday be turned over to SAC.

On the other hand, intelligence elements of the Air Staff, the Strategic Air Command, and influential members of the Air Force headquarters cadre argued heatedly for accelerated development of Subsystem I and for early creation of an "operational capability." Until 1959, there was widespread opposition to the proposal that the prototype Subsystem I complex being built at Denver by Thompson-Ramo-Wooldridge be substituted for the desired "standard" installation. But when it became apparent that the slow pace of Subsystem I development would prevent the completion of an Omaha installation before the first Samos E-1 launch, SAC and the Air Force Assistant Chief of Staff for Intelligence (Major General J. H. Walsh) began strenuous efforts to have the Denver equipment moved to Offutt for "blue suit" manning. In part, this insistence derived from their mutual mistrust of ARDC's understanding of and ability to satisfy "intelligence community requirements." Efforts to explain ARDC's viewpoint, that the vast difference between experimental equipment and operational equipment would inevitably prevent any "operational" use of the prototype Subsystem I, were fruitless. An Offutt installation would establish a meaningful precedent for complete Air Force control of military space systems, and against that urge no such "quibbles" could prevail.[6]

In December 1959, ARDC virtually surrendered. Command headquarters instructed BMD to provide for early installation of the prototype devices at Offutt as soon as a degree of reliability had been established by tests. That qualification provided a substantial obstacle, however. From a technical standpoint, the development was not proceeding at all well, a circumstance which made plans for an elaborate Offutt complex largely academic. It was clear that the Strategic Air Command saw Samos as an attack warning device that might make some contributions to general and technical intelligence, while higher authorities in the Pentagon had the view that Samos was an intelligence system with a limited capacity for attack warning.

Although such policy considerations were paramount, technical shortcomings in the system were by early 1960 becoming quite important to the debate. Itek Corporation and Thompson-Ramo-Wooldridge (TRW) had jointly evolved the design of Subsystem I. TRW had subsequently become the sole source subcontractor to Lockheed for the total subsystem. Itek, under subcontract to TRW, had acquired development responsibility for a key element, the center format processor. Both Itek and TRW were comparatively new companies, Itek being particularly lacking in relevant experience. In the course of their relationship, TRW directed multiple engineering changes which Itek personnel failed to consider properly when revising cost estimates. Itek also made a basic major error in calculating overhead costs, originally weighting them at 85 percent of engineering costs. The correct figure, as proved by experience, was 165 percent.

Finally, both Itek and TRW had sadly underrated the technical difficulty of the development. In consequence, Itek reported a mounting succession of overrun costs on its contract during 1959; from an initial overrun estimate of $36, 000 in February 1959 the total mounted to $2.1 million over the next 10 months. Concurrently, the delivery dates specified in the contracts slipped by nearly a year, the performance of the prototype equipment failed to satisfy specifications, and both TRW and Itek encountered new and major technical obstacles to project success.[7] A further difficulty was that Rome Air Development Center had been made responsible for technical management of that aspect of the total Samos program, so that the Samos project office was several echelons distant from the scene of the developments. In the opinion of one experienced officer, the chief responsibility lay with Itek and TRW, but Rome and BMD were partly to blame because of their ineffective management of development.[8]

Had the development been relatively flourishing, the basic equipment would have been delivered and installed by July 1960, in sufficient time to meet the E-1 flight schedules. A successful program might have overcome all criticism and lent weight to arguments for continuing a substantial readout program. But the fact that Subsystem I was in grave technical difficulty, that it was badly managed, and that it was running out of funds tended to increase the probability that the whole readout undertaking might be cancelled.

In the course of the August 1960 program reviews, an "Ad Hoc Group on Samos Ground Handling Data" recommended continuing Subsystem I development through a full system test and moving the completed equipment to Washington for eventual use there. A certain vagueness concerning the technical capability of the system and unsupported optimism concerning project costs doomed the recommendations, however.[9] Almost concurrently, ARDC proposed transferring responsibility for Subsystem I from BMD to the Air Force Command and Control Development Division, at Cambridge, Massachusetts. The suggestion, which originated with General Schriever,* assumed the elimination of all requirements for processing operational intelligence information during the remainder of the research and development period. (Two years and $24.2 million were suggested as appropriate resources. The project had cost some $37.5 million to that time--August 1960.)[10]

One of the major products of the 25 August 1960 National Security Council meeting was a decision to reduce emphasis on the ground data processing equipment. Immediately after securing confirmation of his authority, Dr. Charyk assigned a special study group to the task of making recommendations on disposition of what remained. By that time, it was apparent that the computer chosen as the heart of Subsystem I was unsuited to its assignment, having been outdated by later models, that the ability of the equipment to handle basic inputs was somewhat dubious, and that film processing itself presented problems that had not been solved. TRW was then 14 months behind schedule and in the throes of an overrun that promised to at least double, if not triple, project costs.

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* It will be recalled that ARDC headquarters was concurrently involved in an effort to enlarge the Reconnaissance Laboratory's role in camera development for Samos.

Charyk himself apparently had deep misgivings concerning the prospects of Subsystem I, but at the same time he remained uncertain of its possible importance to the sort of program that might develop. On 13 September he told Greer to examine the situation and to submit detailed recommendations on the future of the ground data subsystem.

General Greer, although having no special animus toward the subsystem, was by that time convinced that recovery techniques offered much better prospects than readout and that Subsystem I development had been generally mismanaged. Whether it could be saved was not so much the question as whether it should be.

In mid-October, after several weeks devoted to careful analysis of the readout situation, Greer urged Undersecretary Charyk to terminate the Thompson-Ramo-Wooldridge contract and to begin considering something new, a system more completely responsive to real Air Force needs. Greer had been particularly upset by some of the peculiar compromises made in Subsystem I design in order to permit it to accept several varieties of input. "I object," he said at one point, "to a system that accepts five-inch by 25-inch exposed film

(E-5), reduces it, and chops it up . . . to fit an automatic scheme along with U-2 photography, World War II photography, E-1/E-2 take, etc." Adding that his views were his own, that most of his staff was not in agreement, he urged a work cancellation. The subsystem was not essential to Samos operations, Greer told Dr. Charyk. For the purposes of early photo and ferret readout flights, he said, the Satellite Tracking Center at Sunnyvale, California, could handle processing requirements.

In this stand, Greer was almost alone. Charyk's Pentagon staff (SAFMS) urged that Subsystem I be continued, withal at a less expensive rate and with revised objectives, while most of the West Coast group held the subsystem essential to a technically valid program.[11] In each case, a cautious reluctance to discard readout approaches which had been pursued for five years probably motivated the two staffs more than any innate confidence in Subsystem I's technical promise. Neither Charyk nor Greer was disturbed by such qualms, however; each was personally and philosophically committed to a sharp break with the past--if such a break promised to make general program goals more attainable.

On 4 November 1960, Charyk directed immediate termination of all work on Subsystem I except that required to enable ARDC to evaluate the feasibility of employing the equipment elsewhere. Processing equipment for the several remaining readout satellite flights would be provided from other resources, he told the Air Force chief of staff.[12] Within the week, termination notices had been issued to TRW, Rome Air Development Center had received instructions on funding, and ARDC headquarters had been advised of its responsibility for determining the usefulness and final disposition of the developed equipments.[13]

Shortly before Christmas of 1960, Undersecretary Charyk approved a total expenditure of [redacted] in fiscal 1961 funds to close out the project. (Total program cost approximated [redacted] including the 1961 funds.) Roughly [redacted] had been expended before the November cancellation, [redacted] was needed to cover work still on the contract, and [redacted] was provided to finance contract termination actions. The decision met a final anguished protest from the Strategic Air Command, which pleaded for continued development and test of Subsystem I as an integral unit, but Charyk was adamant. He had concluded that the entire concept of Subsystem I was obsolescent. He put an end to speculation that a new and more elaborate system might eventuate by asking ARDC to propose a "good solid research and development program" to result in equipment capable of processing all Samos film; Charyk emphasized that he wanted not a system proposal, but a program to develop "simple and practical equipment." When nothing promising appeared by February, he ordered all Subsystem I activity to be closed out by 21 July 1961.[14]

Large among the reasons for ending the development was cost. For an input of nearly [redacted] the Air Force had obtained a semi-obsolescent lot of partially developed equipment tied to an abandoned concept. In the final analysis, Subsystem I had been designed to satisfy the pre-1960 requirement for early attack warning; the shift of emphasis from surveillance to reconnaissance in July 1960 had doomed the development, although full appreciation of that circumstance was not widespread.

The factor of technical failure in the development program itself was certainly an element in the termination decision. But though engineering difficulties were substantial, greater obstacles had been overcome elsewhere in the Samos program, and the responsibility for the ultimate collapse of the development program had therefore to be credited as much to improper management as to anything else. Separated from the conduct of development work by an intervening ARDC center and two layers of contractors, the Samos project office was never able to maintain sufficiently close control of the engineering effort. The unfortunate fact that both of the principal contractors were relatively inexperienced in such work was certainly a contributor, but probably not a determinant. Experience in satellite reconnaissance was not an abundant commodity, after all.

One other significant aspect of the termination deserved notice. Between the time that Charyk received Greer's recommendations and the time of an absolute, final cancellation, only two weeks passed. The recommendation itself was based on an analysis that took less than a month. Both the assurance and the speed with which the new Samos management group acted showed that more had changed in the program than the technical character of some of the subsystems. A new impatience with failure lay close to the surface.

E-1 and E-2

Doubts about the worth of continuing the still-scheduled readout tests were apparent in the wake of the Subsystem I cancellation but were generally subdued by the absence of any flight data that could confirm judgments on system feasibility and usefulness. Both Charyk and Greer were certain that the readout system would return photographs, but whether such photographs would be of a useful quality remained to be seen. They agreed to await results of flight tests before deciding the program's future. By the end of 1960 there was no longer any question of Corona feasibility, and in terms of utility for reconnaissance purposes the worst of the Corona returns was certain to be better than the best of the E-1 photographs.[15]

Nevertheless, empirical evidence remained the best basis for judgment on program validity, and in the absence of flight data on which to base a finding the cancellation of the E-1 program might prove difficult to defend. It was also pertinent that by late 1960 the second flight vehicle was ready for launch; cancellation thereafter would have saved the cost of launching one Atlas-Agena, but payload expenses could not have been recovered and in any case, as yet the booster combination had not recorded a success in orbiting a reconnaissance payload, so termination would have been costly in prestige, as well. All in all, the arguments for attempting the second E-1 launch were more compelling than those against.

By early January the vehicle was on the stand and had been checked out. At that point a new complication arose. Negotiations with the Soviets for release of two imprisoned members of an imprudent RB-47 crew were approaching a climax; the newly installed Kennedy administration was extremely anxious to establish an early record of diplomatic achievement by getting agreement to the crew's return. In mid-January, with the E-1 on stand and ready, General Greer received urgent encrypted instructions to delay the scheduled launch by some plausible subterfuge until the freed crew could actually be returned to American custody. He explained the situation to Colonel H. L. Evans, his deputy, and they concocted the scheme of having the colonel appear before the general in the company of two "unwitting" program office specialists with a suggestion that the E-1 launch be delayed by a week or so to permit a final recheck of launch readiness provisions. Deliberately unspecific but convincing references to difficulties and uncertainties involving the telemetry stations, range procedures, and checkout processes made up the bulk of Colonel Evans' remarks. With counterfeit reluctance, General Greer agreed to a postponement. Once the released Air Force crewmen had been returned, the occasion for delay vanished--and so did the technical obstacles Evans had materialized for his appeal to the general.[16]

There followed the 31 January 1961 launch of the second Samos vehicle (number 2102). Like the first, in October, it carried a composite E-1 camera. Unlike the October vehicle, however, the second Samos went into a stable orbit and relayed information to the readout station at Sunnyvale. (The orbital vehicle had a period of 95.2 minutes, a perigee of 260 miles, an apogee of 311.6 miles, and a nominal life expectancy of 1130 days.)

On 3 February, Colonel King took the first analysis of flight results to Dr. Charyk. An assembled photograph was available which indicated that the ground resolution of the system was roughly what had been anticipated, about 100 feet. Although the hand-processed pictures were relatively good in terms of original system requirements, the system itself did not promise much in the way of eventual utility. There seemed little justification for altering the premise of the previous eight months--that the E-1 would be tested only to prove out the feasibility of the in-flight processing, transmitting, and readout equipment.

General Greer was closeted with Undersecretary Charyk for most of three days starting on 13 February. Among the many Samos program matters discussed and decided during that period, one of the chief was the future of the E-1 and E-2 launches. As had been generally anticipated, Charyk agreed that the relative success of the 2102 vehicle was a sufficient proof of E-1 system feasibility; he approved General Greer's recommendation that the third of the programmed E-1 flights be cancelled and the equipment stored for some possible future application. They also agreed to let the scheduled E-2 flights remain in the program for the moment, although again it was apparent that once a set of returns had been received there would be no real justification for further continuance of the E-2 program.[17]

In effect, the February decision halted all work on the remaining E-1 system (vehicle 2103) and caused it to be returned to Lockheed's Sunnyvale plant for bonded storage. All of the necessary directives were in circulation by 15 February, one day after Charyk's verbal instructions to Greer.[18]

There was one additional, almost afterthought aspect to the E-1 program. In April 1961, representatives of the National Aeronautics and Space Administration (NASA) contacted Dr. Charyk's office to ask permission to examine and use E-1 technology in their own programs. It seemed possible for a time that the physical products of the E-1 development might actually find their way into a moon vehicle. One stimulant was the obvious parallel between E-1 equipment and techniques and the devices used by the Soviets to photograph the back surface of the moon in October 1959.

The Soviet feat had excited admiration from a number of American specialists in reconnaissance and from astronomers in general. (The lunar pictures, incidentally, represented the first public disclosure of satellite photography and stimulated considerable conjecture about the existence and capability of a Soviet reconnaissance satellite system.) Without giving any indication that he knew of the E-1 and E-2 specifications, Amrom H. Katz, Rand's foremost optical physicist, calculated the relative ground resolution of the Soviet camera and data link system at about 250 feet from an altitude of 300 miles. That was a shade less effective than the E-1, though in practice the considerable difficulties of transmitting photographic data over distances ranging from 30,000 to 200,000 miles tended to invalidate any general conclusions on that score. (The Soviet system had employed an eight-inch F/5.6 lens and a 20-inch F/9.5 lens to produce simultaneous photographs, each on one-half of a single frame of 35 millimeter film. Katz and others estimated that transmission of a complete negative required about 20 minutes. The satellite never approached closer than 40,000 to 50,000 miles to the moon but nevertheless returned photographs which showed a ground resolution on the order of 5-10 miles.) In the realm of the theoretical, it seemed that the slightly more sophisticated--on paper, at least--E-1 or its E-2 successor might permit the United States to obtain better pictures. At least NASA seemed convinced--so much so that Undersecretary Charyk authorized that agency to deal with the E-1 contractors through General Greer's office. Charyk instructed Greer to permit access to technical data on the camera and on-board processing equipment, data transmission elements, and the ground processing system. However, he forbade the release of specific satellite photography or detailed test results.[19]

There was considerable doubt in informed quarters that the E-1 devices had any useful application to the problem of lunar photography; both Rand and Colonel King freely expressed reservations on that point. Indeed, as analysis of E-1 results continued and as the fund of precise information on system capability increased, confidence in the system tended to decrease proportionately. Concurrently, there was a growing awareness that it would be most difficult to fund all of the assorted Samos systems in the next fiscal year, a circumstance that caused program managers to give new thought to early cancellation of the entire E-2 program. Early in March 1961, when the fiscal 1962 budget for Samos was undergoing final review, the question of what could be done with funds that, though substantial, were definitely limited, focused in part on how many E-2 flights should be carried on the schedule. The issue was complicated by Dr. Charyk's desire to develop and test a mapping and charting satellite (essentially a revived E-4 system) as well as to continue or even expand a basic program that now included [redacted] the E-5, E-6, [redacted] and several variants of Corona. Dr. Charyk was willing to consider cancellation of the E-2 program in favor of a new readout-technology approach with more promise, should that seem the best course.[20]

Although in most essential features the E-2 system was technically identical to the E-1, differing chiefly in the degree of lens magnification, there was evidence that all of the complexities of readout had not been resolved by the relatively successful E-1 flight. In May 1961, for instance, the program office reported that the processing unit in the payload vehicle had repeatedly jammed in the course of check-out tests, that the film record was subject to distortion under certain conditions, and that the ground equipment still experienced frequent random failures.[21] Even before the program review that brought such circumstances to the attention of the undersecretary, he had decided to limit the total of E-2 flights to two. On 19 April, the third E-2 vehicle-payload (vehicle 2122) was cancelled. Another significant change came early in July when a succession of payload, tracking net, and booster difficulties forced postponement of the scheduled launch of the first E-2. Even after the original sequence of such difficulties was resolved, a new onset of electronic trouble in the Atlas booster again caused postponement of the launch date into September.[22]

On 9 September 1961 the initial attempt to orbit an E-2 payload ended in an awesome launch pad explosion. Loss of electrical power caused the Atlas to drop back on the pad less than two seconds after liftoff. The E-2 payload was destroyed in the resulting blast and fire. (The Atlas failure was caused by a delay of .2 seconds in disconnecting the umbilical that carried the signal to switch from external to internal electric power.)[23]

The remaining E-2 flight test vehicle (2121) faced a problem of crowded launch pad schedules. After weighing the prospect of a major malfunction and the clear evidence that basic subsystem performance had been adequately demonstrated in the single successful E-1 flight, Charyk and Greer decided not to launch the second E-2 vehicle. On 30 September the contractor was instructed to remove it from flight readiness processing and put it in bonded storage. For all practical purposes, such action concluded the original readout-oriented Samos program.[24]

Colonel W. G. King, responsible for those aspects of Samos which predated the August 1960 reorganization, saw clearly that the decision to store rather than launch the remaining E-2 payloads meant that readout, "as presently conceived," was no longer "an acceptable alternative solution to the earth recce problems facing us." On

6 October he issued instructions that all work on readout should halt immediately, cautioning the procurement office to look carefully to be sure of finding "a lot of the efforts which are hidden in the bushes . . ." He wrote a brief epitaph with the phrase, "It is presumed the present readout program is defunct."

Colonel King's experience with the E-1 and E-2 had not convinced him that any of the equipment was applicable to NASA's moon reconnaissance program. He remarked mildly that "the gentlemen" with whom he had discussed the NASA proposal "did [not] seem to understand much about the problems of taking pictures from a space vehicle," but then he had earlier concluded (as had The Rand Corporation, independently) that little of the basic equipment could be adapted to a lunar reconnaissance program. His own draconian preference for disposing of surviving payloads was to offer one of the E-1's to a museum and to give the remaining E-2 vehicle to anybody who could afford to fly it.

The residue of the readout program was initially concentrated at Vandenberg Air Force base, although bits and pieces finally settled at other sites over the country. The two remaining E-1 flight models remained at Vandenberg, together with spare parts sufficient to make a third payload. Three assembled or partly assembled but untested

E-1's were stored at Sunnyvale. One E-2 flight model and parts for another were also in Vandenberg storage. Two other non-flyable test models remained, one at Eastman Kodak's Rochester plant and the other at Sunnyvale.[25] After September 1961, there were no serious proposals for Air Force utilization of the equipment, even though lunar reconnaissance kept bobbing up. The flyable payloads went into storage at Milpitas, California, and the Agena vehicles not adaptable to other programs with them. Contractors converted to other uses most test items. Readout in its original form was, as Colonel King had observed, "defunct."

That being the case, King felt himself free to state several viewpoints that would have been considered inappropriate in the manager of a major readout development. Although he agreed that many people thought readout might be the "ultimate" system, King could see no reason at all for developing such a device. A good system, he told Colonel J. R. Ruebel, required a reliable long orbital life, an invulnerable long unattended life, boosters capable of lofting large power supplies, and a readout network capable of doing a first-rate job. The combination, he observed, would be "tough to provide--and costly." ". . . Why spend your time creating a problem so you can work on it?" he wrote Colonel Ruebel.

It was also apparent, King noted, that no readout system then conceivable could provide the clarity or definition of recovered film. What could the readout system sense that a small-time differential would degrade, he asked? Would a readout system be more economical thana recovery system if estimates properly weighed the cost of amortizing development? King thought not. He was convinced that with the possible exception of better response to low levels of illumination, everything a readout system could do a recovery system could do better. The need for long on-orbit life pushed a readout system so far out into space, for example, that a 10-foot recovery system would always become a 20-foot readout system.

As for the future, King felt that development of traveling wave tubes would indeed allow much more information to be transmitted, quickly and accurately, than current six-megacycle systems, but he noted acidly that a great deal more would be required to make readout compatible with any of the recovery systems then in development. So, he asked, "Why develop something that will take weeks to cover the same ground that you can cover in 5 days?" As for technology, not only was a stabilization and aiming system capable of supporting a very high resolution readout system rather remote, but it promised to be very expensive. Perhaps more important, an electronic data link was much more vulnerable, both physically and politically, than any recovery system.

Not even when the proposition was a continuing research program pointed toward possible needs five years hence did it satisfy Colonel King's standards. He was convinced, he told Colonel Ruebel, that reliable recovery, even reliable recovery of several packages from the same orbiting vehicle, would always prove simpler than providing a combination of reliable long life on orbit with a good data link. Five years in the future, satellites might provide the only source of reconnaissance information, but by then both readout and recovery would be difficult and the earlier advantages of recovery would have persisted.*

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* Some of the arguments against readout, though not Colonel King's, were based on advantages of the E-5 and E-6 over the E-1 and E-2 which were the product of general advances in the state of the reconnaissance arts. The E-1 was a fixed camera covering a 100-mile swath on the ground while the E-2 had a stabilized rotatable mount to provide 17-mile-wide strip coverage within a 300-mile-wide strip along the ground track. Maximum resolution of the E-2, under ideal conditions, was on the order of 20 feet. In practice, a resolution on the high side of 35 feet could be normally anticipated. Better optics, improved techniques of film transport, improved vehicle stabilization on orbit, and modes of panoramic photography made both the E-5 and E-6 considerably more attractive in terms of ground resolution, ground coverage, and general picture quality. But with allowances for the fact that stabilization requirements would be more critical in the case of a camera on 300-mile orbit than for one orbiting below 150 miles, the lens, film transport, and panning advances incorporated in the E-6 might well have been built into a readout system, thus

"In summary," wrote Colonel King, "I don't favor diluting any of our efforts [in order] to build a readout gadget. Despite the pressure to get into readout and electrostatic tapes, etc., I'd say it was a wasteful effort. Started now it would chug along and we would cancel it later anyhow."[26]

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reducing the performance gap. The E-3 design was a case in point. Though it had inherent faults it was in many respects a technical contemporary of the E-5. The basic defects of readout, from a technological standpoint, were those Colonel King constantly emphasized: inability to provide reliable long life on orbit, and the absence of a sound wide-band data link. When those objections had succumbed to some technological advance that could not be accurately foreseen in 1961, evolutions of the potential of readout could take a different direction. As it happened, 10 years were to pass before the objectives King postulated could be overcome--even in theory.

READOUT REVISITED

The abandonment of the original E-1 and E-2 readout approaches by late 1961 did not start a pogrom of readout advocates, nor did it mark the extermination of all readout research. There was notably little enthusiasm for the readout approach within the ruling circles in SAFSP, but with considerably more substance than most ghosts, readout kept materializing, being exorcised, and then materializing again.

The chief 1961 alternative to the technique embodied in the E-1 and E-2 (automatic processing of standard photographic film and transmission of analog data to a ground station) was some form of electronic or electrostatic tape recording. The Air Force had first funded such technology in 1959, during the period when the Advanced Research Projects Agency (ARPA) had controlled the Sentry-Samos effort. Obviously inspired by advice that high ARPA officials were wildly enthusiastic about electrostatic tape techniques, Lockheed had proposed and secured approval of a program to develop the E-3, a high-resolution tape-readout system. By July 1959, when it briefly seemed that ARPA rather than the Air Force might acquire permanent custody of Samos, Lockheed was assuring the Pentagon super-agency that an "all-electronic approach" (electrostatic tape) would "provide the highest possible performance in the earliest time period at minimum cost."

Such enthusiasm was not limited to electrostatic tape applications but as the occasion required could be extended to encompass a variety of interesting technical gadgetry then under consideration. Lockheed--and the Wright Air Development Center's Reconnaissance Laboratory--contended that the feasibility of an electrostatic tape development had been demonstrated under a research contract, that there was good reason for optimism concerning an image orthicon tube development, and that at least three alternative projects (the CBS Laboratories' Reconotron, General Electric's Thermoplastic Tape, and the Westinghouse EBICON device) promised greater sensitivity and less complexity than any conceivable film approach.[27] In electrostatic tape, however, both Lockheed and the Wright Field laboratory saw real promise. They pointed out that in theory a tape system could provide the equivalent of 100 lines per millimeter resolution (12,200 television lines for each 61-millimeter-square frame!) using an F/4.5 lens and a slit shutter set for three-millisecond exposures.* Assuming the availability of a 12-megacycle-per-second bandwidth, experimenters calculated that readout time would be but 8.7 seconds per frame--as opposed to the several-minutes-per-frame of the E-1 system.[28]

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* The readout technique used a sandwich-type electrostatic tape containing a very sensitive photo conductor and an accompanying

Although the carefully organized demise of the E-3 program late in 1959, one of the first of Air Force actions or regaining full control of Samos, eliminated the possibility that a major portion of the satellite reconnaissance effort would be diverted to gadgets that could not realistically be readied for initial tests in less than three years, the investigation of "E-3 type technology" was continued--at a relatively low level of financing. In the fall of 1960, when impatience with the lack of progress in Samos development caused the establishment of General Greer's Directorate of Special Projects (SAFSP),* at least one member of the DDR&E (Directorate of Defense Research and Engineering) staff queried the Ballistic Systems Division concerning the "adequacy" of support for electrostatic tape development. Colonel H. L. Evans, the Ballistic Missile Division's vice commander for satellite systems and a veteran of the E-3 episode of 1959, hastily assured the inquiring authority that "present support" was quite adequate.

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insulator, the tape receiving and storing a high quality image picked up through the lens. Readout itself involved the process of deflecting the modulation of an electron beam which was magnetically guided to scan the area of the tape on which an image was recorded. The resulting video signal was amplified in transistorized amplifiers and then applied as a modulating signal to a transmitter tuned to a ground station.

* Originally, Director of the Samos Project.

He added that there was no immediate prospect of transition from an advanced research program to a system development, the technology being as yet inadequate.[29]

After SAFSP's establishment, funds were obtained to continue research into the electrostatic tape approach. The Aeronautical Systems Division, which had inherited the Reconnaissance Laboratory through a 1961 reorganization, retained custody of the program on a "monitored activity" basis. The Wright Field people were honestly convinced that they were working toward an early operational camera system based on RCA's electrostatic tape process; West Coast specialists better contained their enthusiasm and their expectations. Nevertheless, by September 1961 the proponents of the RCA system were able to prompt a formal evaluation of their proposal. Unhappily (from their viewpoint), the SAFSP engineers who evaluated the proposed system had to report that obtaining the requisite four-foot resolution "would mean developing a very complex system" even though "many technical and operational problems [are] yet unsolved." Power supply limitations promised to keep any tape system from remaining active for more than two months on orbit, with one-month life being a real possibility. The only approach then feasible could be to mate the tape system to one of the existing readout-mode reconnaissance systems, thus providing at relatively slight cost the essential optics, vehicle, stabilization, command and control, and six-megacycle data link.[30]

Largely on the basis of that appraisal, SAFSP in November 1961 advised the Aeronautical Systems Division of its readiness to listen to proposals for developing a camera--less optics--suitable for environmental and functional testing of the electrostatic tape equipment. Wright Field, in response, estimated a 15-month effort that would cost General Greer's organization from [redacted]

Perhaps the cost, perhaps the awareness of technical uncertainty proved sufficiently impressive, but in any event it became clear that no such major program would be carried through on SAFSP money. What did result was a proposal that SAFSP (through the Air Force Space Systems Division) provide some [redacted] in fiscal 1963 money, with the Aeronautical Systems Division investing a like amount. (In the preceding three fiscal years, the Samos project had furnished about [redacted] and the Reconnaissance Laboratory another [redacted] to support the electronic readout work.) Since the E-2 system had been cancelled before these proposals could be refined, the E-6 became a leading candidate to provide optics and stabilization elements. Advocates of the E-2 approach still were heard, however, chiefly because the difficulty of adapting E-6 optics and film transport to the tape devices seemed considerably greater than the difficulty of adopting E-2 subsystems. The realistic objective for the immediate future, however, was to obtain a "breadboard" version which could be usefully tested aboard an aircraft. No orbital experiments were seriously considered in the circumstances of the moment.[31]

There was little doubt of SAFSP interest, but in the middle months of 1962 there arose a substantial question about the technical adequacy of the proposed RCA approach. The first test results reported to SAFSP proved quite disappointing; in April 1962 Captain Frank Gorman (U.S.N.), the chief of advanced planning for General Greer's establishment, urged the Reconnaissance Laboratory to retest for sensitivity (equivalent of film speed), resolution, and dynamic range (equivalent of gray scale in photographs). Subsequently, when few data were forthcoming, Aerospace Corporation personnel contacted RCA directly--a development that brought a pained protest from Wright Field, fearful that RCA would become too fond of dealing directly with the customer for satellite systems. Gorman reassured the Dayton laboratory that he had no intention of letting Aerospace Corporation pirate the development program.[32]

A meaningful revival of interest in readout came in October 1962, almost entirely prompted by the Cuban missile crisis of that fall. A major Air Force achievement had been the successful relocation and operation of a cloud-cover satellite system, the "Program 35" satellite and ground complex developed under cover of SAFSP activity.* Enormously impressed both by the flexibility of the satellite system and by its application to a crisis situation, Undersecretary Charyk, after brief consideration, asked General Greer to propose a readout system capable of providing surveillance capacity over specific limited areas of the Soviet heartland. It was in some important respects a regression to the requirements of the pre-1960 period, when warning rather than reconnaissance was the program objective. (One side effect of the episode was a quick inventory of available E-1 and E-2 payloads; three flyable systems were located.)

General Greer responded by instructing Captain Gorman to "develop a plan for a mobile surveillance satellite system" based on electrostatic tape or some other electro-optical recording method. (The P-35 satellite had used a derivation of the Tiros television recording system.) Gorman's goals were to be a system concept and a development plan. Greer did not really care which of several basic vehicle concepts was employed, although he suggested paying particular attention to wheel-type and spin-pan-type vehicles.[33]

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* Discussed in Chapter VIII.

In point of fact, General Greer found it difficult to become particularly enthusiastic at the thought of any new readout development program. Thoughtfully, he retrieved Colonel King's unkind epilogic remarks on readout from the file where they had been resting for nearly a year and after reading them again he opened an extensive personal inquiry into the potential and limitations of readout in general. The result was an essay, "Anatomy of Readout," built around a series of mathematical calculations of readout's theoretical and probable utility. He concluded that the best obtainable readout system would require about 700 seconds to transmit the information it could acquire in one second. Any readout satellite would need 40 days of reliable operation to equal the gross product of available recovery systems that could photograph 100 targets a day for three days in orbit and which could make all of its photographs available for examination within three days of recovery. (With 10 ground stations to read out satellite information, Greer calculated, the readout system might in five days equal the recovery system's three-day output.) Apart from obvious disparity in resolution potential which made recovery so attractive, an operationally useful readout satellite would also have to overcome Colonel King's basic objections that current technology could not provide for long-term untended reliability on orbit, for inexpensive ground stations, and for considerable improvements in data transmission.[34]

Anything that promised to satisfy such requirements would have to come from work supported by the Reconnaissance Laboratory at Wright Field. When interest suddenly spurted, in October 1962, the project could look back on four independent efforts to develop an electronic camera having significant advantages over a conventional silver halide image device. RCA had devoted considerable effort to developing a photo-conductive tape system and Westinghouse to photo-emissive tape. General Electric touted the virtues of a thermoplastic tape system. Chance-Vought had explored the potential of a modification of the Xerox process. The Navy, which had provided virtually all funds for the Chance-Vought investigation, dropped the project in 1962. Even earlier, the Reconnaissance Laboratory had given up on the General Electric system and was then in the process of closing out the Westinghouse activity. RCA remained, "on its merits," to quote the project officer. All of the other artful techniques had displayed apparently unsurmountable defects in resolution, sensitivity, and handling requirements.[35]

The advantages of electronic tape, apart from those ritually urged whenever devotees of readout gathered, lay essentially in a greater sensitivity than film (by a multiple of at least 50) and in the promise that a shutter mechanism might be electronic rather than mechanical. (Both vibration effects and reliability were markedly influenced by shutter design.) As compared to film, tape had another advantage for a period of "hot war"; although exposure to nuclear radiation might wipe away any sorted images, it would not so affect the reuse potential of the tape. Other advantages, as seen by project advocates, tended to hinge on the availability of techniques not yet generally proven--such as 20-megacycle-per-second data links having a 30-decibel signal-to-noise ratio, or an 80-megacycle link "developed and demonstrated by the Communications Laboratory at ASD." Such equipment was purported to be "available" in a form that would qualify it for satellite installation.[36]

The option of reactivating the E-2, and improving its technology by half a decade, was not readily available. Captain Gorman investigated that situation and concluded that a test of E-2 payloads could not sensibly be funded; it would be prohibitively expensive, if only because system operation depended on the availability of impregnated developing webs which had not been manufactured for two years.[37]

In essence, the non-availability of an E-1 system, the cancellation of three proposed tape systems because of major defects, and the continuation of the requirement posed by Dr. Charyk left Captain Gorman with but one option: investigation of the RCA tape system for possible application to the problem. He therefore asked the Aeronautical Systems Division to provide definitive performance data on the RCA tape system which, he commented, "may have progressed in development to the point where it can be seriously considered for . . . system applications." Late in November, General Greer assigned a relatively high priority to the necessary tests. The investigation had earlier been formalized [redacted] a special study entrusted to a select group of SAFSP officers headed by Captain Gorman.[38]

Early in December, Gorman and several specialist engineers from SAFSP and Aerospace Corporation visited the RCA laboratory to view the electrostatic tape device and to define test requirements, general system requirements, and a method of data analysis that would be used. Funding was being provided in part by the Reconnaissance Laboratory, but the bulk of the money required to finance the special performance tests had to come from SAFSP. The first increment, [redacted] had gone out in October; an equal amount went forward in late January. The total [redacted]as intended to finance RCA's efforts through the end of the fiscal year.

Apparently, however, RCA concluded that a very substantial system development contract, on the order of [redacted]lay at the end of the data demonstration process. The contractor thereupon proceeded to concentrate on producing one impressive picture with the breadboard equipment, without much concern for making funds last until June or, as later became obvious, without too much worry about eliminating major shortcomings of the equipment.

The first series of tests, conducted on 10 January, seemed inadequate in all respects. The Reconnaissance Laboratory's evaluation showed "performance levels appreciably less than had been hoped for . . ." However the Aerospace Corporation estimated that the performance was adequate to the needs of a surveillance reconnaissance program. Product improvement requirements were characterized as "modest."[39]

Captain Gorman, much less impressed than Aerospace Corporation reviewers, described RCA's system performance as "worse" than initially thought, but still capable of improvement "with a hedge for unknown technical factors and a big hedge for RCA management." On the day that Gorman set that judgment on paper, RCA submitted a formal proposal for immediately accelerating work to a [redacted] per month level and for organizing the effort on a system basis. This although the Reconnaissance Laboratory project engineer had downgraded the contractor for deficiencies in "feeling of urgency," long-term planning, anticipation of prospective problems, and general management.

Gorman bluntly told the Reconnaissance Laboratory that no additional SAFSP dollars would be made available for the RCA work that fiscal year, that the contractor should be advised to program his effort to keep funds available until mid-June, and that the fiscal 1964 funding level would be largely dependent on the results of the current program. Within three days, RCA had been so notified.[40]

Undeterred, gaily optimistic and lacking essential experience in reconnaissance and optics, RCA plunged ahead at a [redacted] per month spending rate, gambling on the successful demonstration of system performance and the award of a substantial contract by 1 April. Apparently neither SAFSP nor the direct project managers at Wright Field were aware of the RCA decision, although visitors to the RCA facility must on occasion have come away shaking their heads in wonderment. As late as 1 March, for example, the contractor had not selected a full-time program chief.[41]

Notwithstanding the sometime Disneyland aspects of some RCA activities, results of system tests conducted late in March seemed to have fully justified the Reconnaissance Laboratory in its consistent optimism. The project officer reported that RCA had produced a good picture: 40 line pairs per millimeter, 2:1 contrast ratio, equivalent film speed of 1.0, and an acceptable signal-to-noise ratio. He wrote his SAFSP contact that RCA had satisfied its promise to prove feasibility of the system by 1 April; further "financial assistance" was warranted, he concluded.[42]

Although the "good picture" (which RCA said it could not repeat, the only available electron gun having failed!) had not come to the West Coast with the project officer's report, a high degree of optimism seemed warranted.

Six days later, it seemed almost as though another picture was being discussed.

In the interim, the Wright Field project engineer had taken a closer look at the "good picture" and had asked several colleagues to appraise it. Resolution, they agreed, was nearer 18 than 40 line pairs per millimeter. The other parameters were proportionately downgraded. The laboratory engineer apologized for taking RCA's word for picture quality and concluded, somewhat plaintively, that RCA was "still incapable of performing measurements on Photo-Tape which are meaningful."[43]

1001

Concurrently it became obvious that RCA had spent money at a rate of [redacted] per month and had neglected other elementary program precautions. SAFSP's rejection of the spurious analysis and demand for a more meaningful test fell into a financial vacuum. No money remained. On 6 May, RCA stopped work entirely. All that remained of the [redacted] allocated for the year was a [redacted] reserve to pay for the final report--and RCA could not readily use that sum because of disagreements over fees due. The activity simply sputtered into silence, due for a relatively low level of funding in the approaching fiscal year.[44]

Although there seemed little enough reason, some of those who had become involved with RCA maintained their earlier optimism. One Aerospace Corporation scientist said cautiously that RCA was making progress, but added that the contractor had given no real consideration to environmental problems and that the laboratory models were far removed from flight hardware. Concentrating on the electronics of the proposed system, RCA had ignored the mechanical aspects of tape transport, had no real understanding of reconnaissance needs, was out of tune with system design trends, and would need close monitoring in any continuation of the program.[45]

As it happened, RCA was relatively honest in the affair of the picture, but the explanation laid open an appalling error in basic understanding. As explained by the contractor's marketing manager, who had experience in putting the best face on unfortunate developments, RCA had through a "regretable misunderstanding" not known until after submitting both the pictures and the appraisal that the Air Force standard for determining photographic resolution differed from the television standard--by a factor of 100 percent. Photographic "line pairs per millimeter" standards counted each line and space combination as a unit; television standards counted a line and space as two lines! In a thoroughly subdued evaluation of its own performance, the contractor conceded to unwarranted optimism and the failure to recognize that the system involved photographic as well as electronic problems.[46] An interesting unanswered question was whether RCA had for 16 months been diligently trying to build a system capable of reproducing 35 line pairs per millimeter while Air Force project officers continued to believe that 75 line-pairs was the object of the program.

After the furor died down, RCA was modestly financed for another year of development. (There was clear understanding, this time, that the technical objective was a demonstration of 75 cycles per second resolution--a "cycle" meaning line and space to both the television industry and the Air Force.) The goal of the revised program was demonstration of the desired functional utility by March 1964, a possibility that the project engineer thought somewhat uncertain because of continued poor management at RCA. The contractor was considerably more conservative in his goals--and claims; his immediate objective now was a flyable system that could resolve 50 cycles at 1.0 (ASA) film speed by mid-1965. The goal seemed not unrealistic. On the other hand, it had no particular technical appeal.[47]

In a sense, [redacted] died at birth. Notwithstanding a considerable degree ot optimism--always most pronounced among those who knew the least about photographic and electronic problems of readout--there was nothing to recommend for near-term development. The E-1 still was the only readout system to have demonstrated any reconnaissance capacity in operation, and the E-2 still was the most advanced of those with any near-term availability. None of the various electrostatic or electronic devices approached operational feasibility. The CBS Reconotron, in development quite as long as RCA's electrostatic tape camera, had developed 100 lines per millimeter resolution in system elements closest to the optics, but would lose from 50 to 75 percent in focus and readout processing. The Westinghouse tape seemed to have no promise at all.[48]

In a special staff study completed in May 1963, Captain Gorman's plans office determined that the theoretical maximum rate of readout was 4.65 square inches of film per megacycle per minute at 100 lines millimeter. This, Gorman reported, "can not be exceeded with any kind of system." In practice, degradation of the signal-to-noise ratio, extension of gray scale requirements, and the need for fine scan techniques to avoid degradation of resolution would make the actual transmission range between 0.98 and 2.93 square inches per magacycle per minute. Digital techniques would permit better transmission than analog readout, although under optimum conditions an analog system had resolution advantages over a comparable digital system.[49] Other formulae devised by other experts differed in specifics, but the general conclusion--that readout limitations were very considerable and that substantial advances in technology would be necessary before any significant advances could result--seemed common to all.

There was obviously a continuing demand of variable intensity for a system that could be put in orbit and turned on and off as circumstances required--one capable of detecting actions indicative of a hostile intent on the part of an observed enemy. In its essentials, the recurrence of demand for a readout system was a symptom, an indication that the formal abolishment of the "surveillance and warning" satellite requirements of 1957-1960 had not eliminated the sentiment that originally prompted them. Technical attractions were less compelling. Electrostatic tape, despite its demonstrated failings, offered relative insensitivity to radiation in the Van Allen belts where a long-life satellite would have to take station, somewhat better spectral sensitivity, and a degree of selective target quick responsiveness that "sudden-launch" satellites would never be able to match. In other respects it remained inferior to recovered film. Data transmission time was the greatest difficulty, even though new multiplexing techniques offered some promise for wide-band transmission.[50]

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1. Ltr, Col W.G. King, Dir/Samos Proj, to BMD Exec, 23 Sep 60, subj: ...Chronology ..., in SSD Hist Div files; Sentry/Samos Chronology Mar 59-Dec 60, in Samos files; rpt, LMSD Preliminary Test Report, 11 Oct 60; memo for record, LtCol E.F. Blum, Ch Agena Div, BMD, 24 Oct 60, subj: SAMOS GSE Associated Problems During SAMOS I Launch, 11 Oct 60, both in Samos files.

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VIII THE P-35 WEATHER RECONNAISSANCE SATELLITE PROGRAM

Prefatory notes:

At various times the Air Force-DoD weather satellite program was known as Program 35, Program 698BH, and Program 417. After 1964, it also operated under other names of no concern to this account.

Program 35, the weather satellite program that functioned under National Reconnaissance Program authority, was successfully represented to be a closely held space program with no covert or clandestine associations. Few of the people who operated the program office and developed the satellite were briefed on the existence of such programs as [redacted] and Corona, even though Corona was until 1964 the only satellite operation that conceivably could benefit from knowledge of weather over the Soviet Union. The account that follows is based almost entirely on program office sources; that is, the narrative reflects the fact that program managers were largely innocent of knowledge about the way their system would ultimately be used. It must be recalled, however, that until 1963 the original Samos program maintained an official existence, and most Air Force people unaware of the [redacted] and Corona programs assumed that Samos, in one of its several incarnations, was the intended beneficiary of satellite-based weather reconnaissance. The pretense that such was the case lasted until development of the P-35 system had effectively been completed. P-35 was operated under ordinary but rigidly enforced security controls and was not incorporated in the BYEMAN control system although access to information about the program was closely controlled.

In light of the foregoing, this account has been constructed without much reference to other aspects of the National Reconnaissance Program. A slightly different version, denuded of all allusions to covert or clandestine satellite reconnaissance operations, was prepared (by this author) and filed with other program office records in 1965. Apart from occasional references that relate P-35 events to important motivating aspects of satellite reconnaissance program activities, this version conforms to the pattern of the original.

Finally, this account extends only to late 1963, by which time the original program goals had been wholly satisfied.

Like communication satellites, the development and operation of military weather reconnaissance satellites was until late 1960 more a matter of politics than technology. Existing weather satellite proposals and embryonic programs generally were absorbed by the National Aeronautics and Space Administration (NASA) in the space program upheaval of late 1958. Weather observation from satellites was plainly the responsibility of civilian agencies under the terms of the National Space Act of 1958, but that did not eliminate concern for military weather reconnaissance requirements that could not be entirely satisfied by NASA programs. Nevertheless, that a weather reconnaissance satellite dedicated to the military would certainly be viewed as redundant and duplicative by Congress was a major factor in the failure of the defense department to approve any of the early Air Force proposals.

The reconnaissance program realignment of late 1960 had implications that did not escape the eyes of major defense contractors. If, as seemed probable, the original Samos effort was to be expanded, there might also be room to insert developments earlier turned down.

On 17 November 1960, while Samos program reorganization was in progress, but before the unique structure of General Greer's organization had been clearly established, the Radio Corporation of America

(RCA) proposed to the Air Force the development of a cloud cover reconnaissance satellite system.

The submission, which went to Colonel H. L. Evans, Assistant Deputy Director for Space Programs in the Air Force Ballistic Missile Division (BMD),* envisioned a 300-pound payload of television components, two readout stations, a satellite control center, and contractor provision of cloud cover analysis services. RCA urged that the system would fill a functional gap in the array of military satellites by exploiting techniques and equipments, many of which had been flight-proven in the course of NASA's Tiros weather satellite program. The use of proven or "off-the-shelf" system elements was a particular attraction to both the Directorate of Defense Research and Engineering (DDR&E) and the Undersecretary of the Air Force, J. V. Charyk, who had recently acquired cognizance over the total reconnaissance satellite program. Even as early as November 1960, it was clear that both of those authorities would have to approve before a system could be funded for development.

Appreciating that more was involved than merely evaluating a contractor proposal for a new satellite system, Colonel Evans and his immediate staff devoted some two months to its examination and to considering how they might overcome some obvious obstacles to securing system approval. The chief technical difficulty was selecting a launch vehicle; the proposed payload was too heavy for any of the available probe rockets and too light to warrant use of the Thor-Agena. Pick-a-back modes were considered in detail and then discarded because of their possible degrading effect on the basic Thor-boosted satellites--which were mostly carrying Corona payloads.

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* Colonel Evans was General Greer's deputy.

The Air Weather Service (AWS), asked to review and comment on the RCA proposal, carped at details of the system as then conceived. AWS favored a satellite that could provide information on night clouds as well as daytime weather, one capable of operating in poor light, and one that would embody a variety of automated functions. What the weather service actually wanted was a mature, highly-sophisticated system built around a complex intercommunication net. There was, perhaps, a degree of bitterness in the AWS reaction to BMD's request for comments; AWS had been rebuffed in a September 1960 attempt to secure acceptance of a system only slightly more elaborate than that proposed by RCA.

Acceptance of the RCA proposal would involve the Air Force in a development that in some respects was directly competitive with the National Operational Meteorological Satellite System (NOMSS)--a circumstance of which Colonel Evans was poignantly aware. A NASA program, NOMSS was intended to serve all using agencies, whether civil or military. The NOMSS program required development of an intricately detailed orbiting device and thus invoked a considerable element of risk. For that reason, it was being brought along in two phases, the first being a satellite called Nimbus which was, in its own right, exceedingly complex.[1]

Having weighed all the available evidence, Colonel Evans in February 1961 suggested to the chief of BMD's Scout booster office, Lieutenant Colonel D. A. Stine, that it might be feasible to develop a variant of RCA's proposed cloud cover satellite for launch via the Scout. A successful combination would be relatively inexpensive, both in payload and booster elements, and it would serve a highly useful function in supporting a variety of Air Force missions--including Samos. By early March, Colonel Stine had gone over the idea with RCA in considerable detail. He sent an enthusiastic report to Colonel Evans. At Evans' direction, Stine and his program office people, with the continued assistance of RCA consultants, put together and formally submitted a preliminary development plan. In endorsing it, Colonel Evans directed that it be expanded to include provisions for testing direct readout techniques during system operation.

While such details were being worked over, and in the midst of discussions concerning means of transmitting satellite-obtained weather data from one coast to another, the entire proposal took a new turn. The Kennedy Administration had come into office in January pledged to an overhaul of the space and missile program. Although the "missile gap" which had served as a convenient campaign issue subsequently proved to be much less significant than had been feared, Defense Secretary R. S. McNamara resolved to carry through a major clarification of the military space missions of the services. In March, he proposed to give the Air Force virtually all responsibility for military space systems. One of the conditions he specified was that the Air Force immediately reorganize to put proper emphasis on space. Early in April, therefore, the Air Research and Development Command was massively overhauled to accommodate procurement responsibilities--and funds--previously entrusted to the Air Materiel Command. The reorganization brought the Air Force Systems Command into being and on the west coast saw BMD segmented into a Ballistic Systems Division and a Space Systems Division (SSD). The latter organization immediately began working on the Air Force portion of a national space program proposal which was intended to integrate NASA and service interests. SSD's initial contribution was to be a "Five Year Space Plan" which, if approved, would give the Air Force the basic authority to establish an interlocked, multi-program military space effort. The cloud cover satellite, attractive because of its apparent technical feasibility and because of its low cost, was promptly swallowed up in the larger scheme.

A not-uncommon metamorphosis occurred at that point. As laid out in February and March, the Scout-boosted satellite would have been a relatively modest program, both in total cost and in the number of vehicles needed for initial tests. In general, it conformed to the real world outlook of Undersecretary Charyk and DDR&E. For the purposes of the "Five Year Space Plan," however, it was markedly elaborated. By late May, it involved 13 launches and a minimum cost [redacted] Packaged with seven other development plans (including a lunar expedition, a military communications satellite, the Saint interceptor satellite, and an inhabited space station), it began a presentation and review process at the division, sub-command, command, and Air Staff levels before finally reaching secretariat echelons. By that time neither the weather satellite nor any other element of what had become a multi-billion-dollar proposal had any real chance of acceptance. The President had decided that putting a man on the moon during the 1960's should be the chief national space goal, and he assigned the task to NASA. Additional funds, in the amount of many billions, went into an expanded ballistic missile program, and the budget ballooned accordingly. Lesser developments, whatever their abstract merits, could not be funded at the levels the Air Force proposed. Moreover, the Air Force still had not been able to demonstrate that a viable space mission existed for anything other than reconnaissance satellites. Although hope remained high, and reassurances frequent, no action was ever taken on the "Five-Year Space Plan" after it reached the upper echelons in the Pentagon.[2]

Nevertheless, the cloud cover satellite did not die of indifference, as did most other of the May 1961 proposals--nor was it assigned to NASA, as was the fate of the lunar landing project. Instead, it attracted the particular attention of Undersecretary Charyk. On 21 June in the aftermath of a presentation involving several of the "Five-Year Plan" systems, he quietly abstracted the main elements and told General Greer's group to put together a "minimum" proposal involving a four-vehicle program. Five days later, Greer approved the "minimum plan" drawn up by his people and sent it forward to Charyk. On 11 July, Charyk submitted it to the DDR&E with a request for approval and funding.[3]

Although the method of securing revision of the original "Meteorological Information Satellite System" had been somewhat unorthodox, it was characteristic of Charyk's method of operation. It apparently signified nothing more than impatience with the painfully long processes of review and revision that typified normal handling of system proposals. In his initial exchange with DDR&E, Charyk proposed a relatively mundane and entirely conventional development process, differing from others of the time only in that it specified the use of fixed-price contracts and a guaranteed delivery schedule. Charyk saw in the proposal a means for providing global weather information during the 1962-1963 period when the Nimbus would be in pre-flight development. He was attracted chiefly by the low cost and ready availability of major components.[*]

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[*] The approach Charyk favored resembled that adopted, with eventual success, for the development of Corona three years earlier and also reflected philosophies that Charyk and Greer subsequently incorporated in [redacted] and Lanyard programs. The justification for development of a military weather reconnaissance satellite lay not solely in the possible delay in Nimbus operations, but in two other factors not generally recognized outside the National Reconnaissance Program. First, Corona was in 1961 starting to return regular packages of photographs of the Soviet Union, and the quality of the retrieved reconnaissance seemed likely to improve if timely weather information could be fed into the Corona operations program. There was an excellent possibility that political objections to Nimbus operations might limit the quantity and quality of information made available to the U.S. military services. Therefore Corona (and other military reconnaissance satellites programmed for later operation) could well be handicapped if they had to depend on data abstracted from a weather satellite program controlled by individuals who honored the "space for peaceful uses" theme NASA continued to proclaim. Second, the timing and quality of weather reconnaissance could not be guaranteed if Nimbus

On 12 July 1961, after the proposal had gone to DDR&E, the undersecretary instructed General Greer to change the security of the proposal from conventional "secret" to "Mandatory Knowledge" and to transmit all program information by a sealed envelope system. He further directed that the proposal be withdrawn from "normal Air Force documentation [processes], and . . . consideration be given to changing [the] name of [the] project."

By 15 July Dr. Harold Brown, DDR&E chief, had advised Charyk that he would support the "minimum program" if it could be clearly demonstrated that the system had advantages over an expanded Tiros development. The undersecretary convinced Brown during a conversation on 19 July and later that day telephoned General Greer that DDR&E had approved the proposal--subject to a set of special conditions. Those conditions, though unusual, were nonetheless implied by elements of the development plan and by the 12 July instructions on program security. Essentially, the program was to be based on fixed-price contracts, was

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or some successor civil system were the provider; the operators of various reconnaissance satellite programs were unlikely to have much influence on the operational control of the satellite or on the disposition of its products. If reconnaissance authorities did intrude, there was the danger of public protests that would in effect advise the Soviets that the United States needed weather information (chiefly cloud cover data), and hence presumably was operating reconnaissance satellites. In the early 1960s, those operations had gone underground and there was no immediate prospect of their surfacing in the near future.

to be continued only so long as flight schedules remained valid, had to be entrusted to contractors aware of and willing to accept the schedule requirements, and was to be given a new name and conducted under special security provisions. The purpose and effect of the qualifications were clear: in no manner was the "normal" Air Force to become aware of the program's objectives, schedules, or techniques. Use of the widely known term "MISS" (Meteorological Information Satellite System) was to cease.*

A special security policy statement that achieved the desired ends was prepared on the day the instructions arrived in Los Angeles. Like the basic Samos under which it now sheltered, the program was exempted from customary review and approval channels, from routine reporting requirements, and from the halo of publicity routinely erected over any military space program that received significant funding support.[4]

Although the cloud-cover satellite seemed relatively innocuous in its main aspects and differed little in function or purpose from the widely publicized Tiros, it quite probably could not have begun development in normal military channels without causing significant controversy.

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* "MISS" was earlier used as the acronym for the abortive "Man in Space Soonest" proposals of 1958-1959.

Having a military objective, employing techniques common to reconnaissance and surveillance satellites in general (though with such gross ground definition that it obviously could supply no significant intelligence on the Sino-Soviet heartland), and obviously of value to the basic Samos systems then in development, the new program was patently unsuited to open management by SSD. Soviet protests against "military reconnaissance" from space were becoming more pronounced in mid-1961, and no purpose could be served by adding fuel in the shape of an acknowledged military weather satellite program. The fact that the "MISS" plan had been submitted and presumably was awaiting approval was well known in the Air Force at large. In all probability, it would have required no more than an approval signal to loose the publicity crews; the Air Force was finding it difficult to outgrow habits acquired when press releases had to substitute for launches and orbits.

In any event, the deed was done. In the next two weeks the program acquired a director, Lieutenant Colonel T. O. Haig; a name, Program 35; a cost structure derived from payload (RCA) and vehicle (Chance-Vought) contractor data; and a set of accepted procedures. In point of fact, full and final approval from DDR&E still had not been received, but there seemed little doubt that it would come.

Colonel Haig had been associated with ground station aspects of the Discoverer program and was admittedly bored with what had become a mundane assignment.* Early in 1961 he had become known to Colonel Evans as an officer of energy and ability. Given the task of finding a program director for the cloud cover satellite office, Evans called Haig and asked if he would be interested in taking on a small program with rigidly rationed resources and limited objectives. Haig instantly accepted, without knowing any program details. Initially, he found himself with four other people to "manage"; they became the Program 35 Office.

Program ground rules had been defined, in considerable detail, by early August. In order to secure DDR&E approval, Dr. Charyk promised to complete the four-vehicle program for no more than [redacted]-and under the fixed-price contracts earlier proposed. Conforming to practices that had grown into a way of life in the Samos program, he ruled that very rigid "must know" security practices were to be established and maintained. No public announcement of any nature was to be made concerning the program; its existence was not to be publicly acknowledged. Maximum use would be made of available hardware (mostly from the Tiros and Scout activities), eventual launch and operation being entrusted to Air Force uniformed personnel, with a bare minimum of contractor support where essential. Charyk's established distaste for the spate of "program documentation" that accompanied any new program or project caused a flat prohibition on such paperwork activity--which was even more pointless than usual in any event, since in this instance there was no place for the documentation to go except to Greer--who had no need for it.

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* Like many other Discoverer participants, he did not know of its Corona aspects.

Reassured by such measures, Dr. Brown on 5 August approved the program Charyk had proposed. Later that day the Air Force undersecretary telephoned General Greer the authorization to proceed with contractual commitments as appropriate. An official document to that end arrived three days later. By that time the Department of Defense had obtained a reluctant but binding agreement from NASA's chief which permitted the Air Force to negotiate directly with booster producers rather than buy through NASA. The principle, which ran completely counter to NASA's instincts and prejudices, was anathema to NASA field officials.[5] (Also to the Air Force. One of the most celebrated interservice squabbles of the 1950s had originated in General Schriever's refusal to let General Medaris contract independently for North American Aircraft Corporation rocket engines, and the Air Force had carefully segregated initial NASA contracts for

Atlas missiles so as to keep NASA's Mercury booster purchasers outside the production plant.)

The first program difficulty came from the reluctance of NASA officials to permit the Air Force to deal directly with Chance-Vought on matters concerning the basic airframe system. The issue finally had to be resolved in Washington. By 12 August, negotiations were complete and the firm had agreed to a 1 March 1962 delivery schedule and to a total cost figure of [redacted] The price was appreciably better than NASA's "firm price" offer--a circumstance that did little to endear Program 35 to NASA officials.[6] Preliminary arrangements for direct contracts covering procurement of the first and second stage motors of the four-stage Scout vehicle were completed by 14 August. It became apparent shortly thereafter, however, that the two upper stages would probably have to be purchased through NASA channels. The production plants involved were working at full capacity and the motors had not yet been flight qualified. A meeting at Vandenberg Air Force Base on 15 August disclosed the need for additional launch and track facilities at the Pacific Missile Range site. Then the tentative agreement with Thiokol covering procurement of the second-stage motors was endangered by the Army's refusal to let Thiokol accept a fixed-price contract because the same motors were being sold to the Army on a cost-plus basis. (The objection seemed well founded, if somewhat Parkinsonian in logic, since Thiokol apparently had no intention of renegotiating its pleasantly profitable arrangement with the Army agency that owned the manufacturing facilities Thiokol used.)

Most of the resulting parleys with the Army were carried on from Washington, principally by Brigadier General R. D. Curtin, chief of the Missiles and Space Systems Office (SAFMS) (which ostensibly was the staff element of Undersecretary Charyk's Samos organization, but actually was the National Reconnaissance Office staff.) In a succession of patient but persistent calls to various Army undersecretaries and finally to Redstone Arsenal itself, Curtin induced the Army to accept a "firm price" military interdepartmental purchase request covering the necessary Thiokol motors. Since Greer had ordered that no action on contracts with Chance-Vought and RCA be taken until there was absolute assurance that the lower stage motors could be acquired precisely as Charyk had directed, the resolution of the Thiokol controversy on 18 August also served as a signal for starting work on the airframe and payload portions of the whole program.

At the moment, one major unresolved item was becoming critical. As originally planned, the Program 35 effort was to have been conducted within the bounds of a rather conventional systems engineering-technical direction agreement with Aerospace Corporation. The modus vivendi had been established several months earlier, in December 1960, as part of the compact that put the E-6 phase of Samos into effect. But by August 1961, negotiations between Program 35 and Aerospace Corporation had done little more than highlight sharp differences over the scope of the contractor's responsibilities and details of funds management. Under the terms of the Program 35 charter, Colonel Haig had a limited amount of money to invest in systems engineering. Moreover, one of the pre-conditions of Program 35 approval had been widespread use of available hardware, and that included the payload. The quantity and scope of systems engineering-technical direction activity was, therefore, certain to be unlike that of other programs. In such circumstances, the Aerospace Corporation was quite hesitant about undertaking to support Program 35.

Unable to obtain the concessions that he felt were essential, Colonel Haig decided it would be feasible to conduct the program without any assistance from Aerospace. With General Greer's approval, he converted the program office into a de facto systems engineering-technical direction agency authorized to call on SSD offices and the wing organizations for any necessary assistance. Both the booster and the spacecraft contractors would operate under the immediate control of the program office. Aerospace Corporation had no role.[7]

By 31 August, Colonel Haig's embryonic program office had prepared a highly detailed development plan--in three copies circulated only to those with a "must know" status. The document defined the purpose and approach of Program 35, as then understood, and identified the chief technical and operational characteristics of the satellite development.

The goal of Program 35 was a weather observation satellite system that would enhance the effectiveness of Samos operations and improve the accuracy of cloud cover predictions for other military satellites. The development was necessary, in large part, because the extant NASA program had deficiencies in development time scales and orbital placement, as well as inappropriate timing of readout signals, politico-security ingredients, and program management controls.

The 100-pound satellite, a 10-sided polyhedron 23.5 inches across and 21 inches high, was to be spin stabilized on an axis perpendicular to the plane of the orbit. The camera, fixed at 90 degrees from the spin axis, would point directly toward the earth once each time the satellite rotated. At programmed intervals the television camera would take pictures of an 800-mile-square area on the earth, the exposures being made when horizon sensors indicated that the lens was vertical to the earth. The images could either be recorded on tape or read out by any suitably equipped ground station within range. Spin axis orientation was to be controlled by a magnetic torque system developed by RCA and in the course of work for NASA's Tiros I. NASA had rejected the technique as unfeasible.

With the satellite in a sun-synchronous 400-mile polar orbit, the system would provide 100 percent daily coverage at latitudes above 60 degrees and 55 percent coverage at the equator. When readout was undertaken during the western hemisphere portion of a pass that included photography, video data on eastern hemisphere cloud cover could be transmitted to the Global Weather Center at Offutt Air Force Base within one hour of its being observed. In a less favorable pass sequence, readout would always be possible within three orbits of sensor activity. Should it prove desirable, either for test purposes or for an actual operation, a direct real-time readout mode could be employed to feed cloud pictures to any ground station within range.

None of those who designed the program expected to encounter any serious technical problems during development. The Tiros-type cloud cover sensor system had been flight proven. The Scout vehicle had been little tested but seemed potentially reliable enough (five successes in seven flights). The satellite would rely on proven satellite control and readout systems and stations, with standard airborne command, control, and readout components from such programs as Advent and Midas completing the technical equipment. Although much of the equipment was experimental in character, it did exist and it was available from contractors who had experience in its fabrication.

Funds were to come from SAFSP resources through an SSD channel, with program management entirely concentrated in the program office. The contractor structure included RCA (spacecraft), Chance Vought (prime booster contractor), Minneapolis Honeywell (guidance and control), and (as solid-fuel rocket fabricators) Aerojet General, Thiokol, and Allegheny Ballistic Laboratories of Hercules Powder Company. Assembly, checkout, and launch were responsibilities of the 6565th Test Wing (later the 6595th Aerospace Test Wing), under SSD control. Satellite control functions were to be exercised by the Satellite Test Center (later the 6594th Aerospace Test Wing) at Sunnyvale. The Air Weather Service would do weather analysis in the Global Weather Center located in the SAC underground headquarters at Offutt Air Force Base, Nebraska.

The actual payload, weighing 100 pounds, would consist of a videcon-camera recorder system similar to the wide angle sensor used in Tiros I and II, plus stabilization and control devices. RCA estimated the sensor system would have an orbital life of 90 days.

The ingenious attitude control system depended on torqueing the axis perpendicular to the orbital plane through an electric-current loop around the perimeter of the satellite. The torque was generated by a ground command that caused current to flow around the loop in the desired direction.

Spin-up during injection of the fourth stage and payload into final orbit was followed by a decrease to 12 revolutions per minute under the impulse provided by a system of "yo-yo" weights. After rotation speed decreased to nine per minute, spin-up rockets could be used to re-energize the satellite.

Pulses generated by the horizon sensor drove a specialized computer which triggered the camera. The recorder component was capable of storing 32 frames of information. Seven frames were required to cover the area of interest for each pass, but the probability of exposing the first frame was only 50 percent, therefore fixed sequences of eight frames were planned.

Changes from the Tiros transmitter were mostly in the direction of transistorizing. Performance was little affected, although both weight and power requirements decreased. The transmitter broadcast a 62.5 kilocycle bandwidth signal at 250 megacycles per second. Frequency modulation would permit a total output bandwidth of 290 kilocycles with two watts of output power. The video data were to be collected by existing 60-foot antennas at Vandenberg and New Boston.

Of the [redacted] initially programmed for Program 35, [redacted] was to be allocated to satellite vehicles and associated equipment, [redacted] to the booster procurement, and [redacted] to satellite control support. The total would buy one prototype satellite, four flight models, four Scout boosters, separation systems, aerospace ground equipment, control and support equipment, technical assistance, and support services.[8]

Program schedules projected at the time the development proposals first went forward to Undersecretary Charyk had to be revised almost immediately, chiefly because General Greer had delayed a program go-ahead order until he had absolute assurance that all contractors had been committed to the types of contracts specified. The delay, principally occasioned by NASA and Army objections to direct Air Force contracts with Chance-Vought and Thiokol, cost the program a month of working time, but the eventual agreements had the effect of stabilizing virtually all predictable program costs. By early October, it was possible to reimburse those Samos activities from which money had been "borrowed" in order to activate Program 35. Provisions for program funding had been essentially completed by 21 October.[9]

For practical purposes, the program office had not come into existence until August 1961 although the first flight was firmly scheduled for May 1962. In those 10 months, the program managers had to complete all of the steps leading to availability of a flight-ready launch system, an orbital payload, readout stations, and the several participating and supporting ground systems. It was inevitable that the pace of program activity should be extremely rapid and that program decisions, when required, should be unusually prompt. Nor was there any squeamishness about bringing pressure to bear where needed. As a case in point, it proved necessary to have Undersecretary Charyk intervene before arrangements could be made for early tests of the third and fourth stage motors in the tunnels at Arnold Engineering Development Center. A briefing to General T. S. Power, Strategic Air Command chief, got space for P-35 facilities in the SAC underground headquarters complex when "through channels" attempts had failed. Issues of this nature were habitually forced to a decision point for action rather than being obliged to struggle through the slower and less certain "normal channels" of Air Force procedure.[10] By late 1961, it was apparent that the approach to satellite reconnaissance had been rid of most of its earlier organizational constraints.

An excellent illustration could be found in the handling of fourth-stage motor problems that cropped up in October. After several earlier danger signs, the first certain indication that the development of the ABL-258 fourth-stage motor was not proceeding satisfactorily reached the program office on 25 October. One day later, Colonel Haig met with NASA representatives to press for the early development of an alternate motor. Six failures in six tests, he told the NASA people, had convinced him that something more reliable was needed. Disconcertingly, Haig discovered that NASA had made no special plans to meet the tight Program 35 schedule and seemed rather casual about the prospect that the ABL-258 might not be ready when promised. Haig, who considered the matter anything but casual, immediately began to assemble cost estimates on a back-up motor development.

Within 10 days, the program office had obtained from the rocket test establishment at Edwards Air Force Base (an SSD subsidiary) a proposal to accelerate development of a device called the "M" motor as an alternate Scout fourth-stage. The propulsion people said they could complete their development and test program and furnish four flight articles within five months--at a total cost of $300,000. NASA, apprised of the option, figuratively yawned, proving quite uninterested and, on the whole, disbelieving.

Haig postponed action pending another trial of the ABL-258. When that ended in a seventh failure, Haig immediately told General Greer that it would be essential to fund development of the "M" motor to insure the validity of Program 35 schedules. Concurrently, the prototype "M" motor completed its third successful firing.

On 16 November, the day definitive cost proposals reached the program office from the 6593rd Test Group at Edwards, Colonel Haig requested and received from General Greer permission to proceed with development of the "M" motor. A purchase request [redacted] was written that afternoon. Major design decisions had been taken by 8 December, fabrication and initial tests were completed in January, and on 16 February the first flight weight motor was test fired at Edwards. The motor, a Lockheed development now designated the MG-18, experienced an insulation failure and operated for only 7.9 of the programmed 12.7 seconds, but the faults were promptly identified and fixed. On 2 April 1962, five months after the purchase request had been signed, an MG-18 mounted in the vacuum chamber at Arnold

Center operated successfully. Precisely three weeks later a flight motor was mated to vehicle 3501, the second flight craft, for spin test and balance checks.[11]

Only five months and one week after Colonel Haig had first acquired sure knowledge that the upper stage development was in serious trouble, a different rocket motor was being prepared for initial use. The implications were in some respects more important for management than for technology. The unsettling effect of learning that NASA had no concept of schedule importance--at least for an Air Force program--was to have long-term consequences. Buried within NASA's genial indifference to program urgency was the conviction that since no publicity had accompanied Program 35 and no bugles were sounding important assignments for the Scout booster, the program could not be particularly critical. It was a yardstick both the Air Force and NASA often used.

The tit-for-tat attitude of some NASA field people was particularly exasperating. Perhaps because the Air Force had resisted NASA's efforts to deal directly with the contractors for Atlas and Thor, or perhaps because of youthful exhilaration natural to a new organization, NASA people openly displayed resentment that Program 35 had somehow succeeded in getting authority to negotiate directly with the engine and airframe subcontractors.

Within the kernel of achievement that represented the first MG-18 success was a germ of particular significance. For practical purposes, the entire development had been planned and conducted by Air Force personnel, most of them in uniform. Quite understandably, they had begun to take a considerable pride in their accomplishment. The Program 35 office, small, tight-knit, mostly composed of young officers who were completely certain that they either had the answers or could get them given half a chance, was developing an intense esprit de corps. Even if read two years after the fact, program correspondence reflected an assurance not common to young, transient, and notably small program offices. Enthusiasm was becoming the most prominent characteristic of Program 35, even this early, and it tended to set the program apart from others. And if the public relations creatures were right, if motivation was lessened by an officer's being assigned a task that was never featured on television, there was a counterpart compensation in the sense of doing something that was so important it had to be hidden from the herd. The phrase "sense of urgency," even if admittedly trite and overworked, described a state of mind that really existed in Program 35. Whether it could be cultured, kept flourishing, remained to be seen.

Many other aspects of system development had made progress during the months when the MG-18 sometimes seemed to monopolize attention. It was particularly encouraging that additional instances of administrative obstructionism could generally be squashed as they appeared. At about the time the NASA-ABL fourth-stage motor experienced its seventh failure, the Pacific Missile Range began making official noises about priorities. Requests that military personnel be assigned to training slots for Program 35 produced counter demands for development plans, normal "through channels" program authorization documentation, and priority authentication from Air Force headquarters--none of which the program office could furnish under the existing security and management ground rules. An elaborate Program Requirements Document (PRD) had been completed and delivered to the range on 3 November. That seemed, to the program office, quite enough. But range officers were not satisfied. After two weeks of formal conversations proved fruitless, Haig again stormed the Pentagon. On 16 November 1961 the Department of Defense formally instructed the Pacific Missile Range to support Program 35--development plan or not.

Another Gordian knot parted with General Greer's decision to operate the readout stations under a contract with RCA. That highlighted another difference between Program 35 and most other Air Force satellite developments. Early in December, Colonel Haig briefed the commander of the Air Weather Service on the program's objectives and schedules. As Haig remembered the event, the Weather Service seemed about as interested in the prospect of a more elaborate follow-on development, something more complex and expensive than his project, as in what Program 35 might represent. At any rate, the Weather Service would not agree to furnish military personnel to operate the equipment.[12]

The period from December 1961 through March 1961 was largely taken up with detailed engineering work and surveillance of contractor progress, particularly in computers, motors, and payload--the three most critical areas. But there were rumblings of new difficulties with NASA early in February, and they grew ominous as the month wore on. Although the first Scout booster scheduled for Program 35 was not accepted until 2 March 1962, a month earlier the program office had become desperately concerned with the possibility that sufficient spare parts might not be available to support the test program. Again, NASA's attitude seemed infuriatingly casual. The local NASA representative was an Air Force officer who in the opinion of some Program 35 people had lost his perspective on the real world. He told Haig's principal assistant, Fritz Runge, an engineer who had been involved with development for 10 years and with satellites for 5, that the best way to handle the spares problem was to allocate [redacted] in procurement funds to NASA and stop worrying. Runge's report of the meeting was composed of equal parts of irritation and bewilderment.[13]

A partial explanation certainly lay in the fact that within NASA only the three senior administrators were aware of the real objectives of Program 35. That situation, which was controlled less by Air Force desires than by the wishes of NASA's top managers, was a real source of difficulties in communication. Virtually nobody in NASA understood why Program 35 was important, and in the hoary tradition of all those intellectuals who for centuries had looked down on the centurion from the vantage of scholasticism, most of NASA decided not to be impressed by the parochial pretensions of a few relatively junior Air Force officers who were showing inexplicable signs of premature apoplexy.[14]

The problem was in two parts. Outside the reconnaissance field, from which all casuals were excluded, there was no real Air Force space program--a fact that NASA appreciated well in advance of the Air Force, victimized by its own propaganda. Most NASA scientists honored the tradition of Wernher Von Braun, who admitted to only one goal in life--manned space flight. Since it was obvious that no program based on use of the Scout vehicle could have either immediate utility or lasting significance--it certainly was not a reconnaissance project, and the Air Force had nothing else worth mentioning--and since it would interfere with other NASA activities that were leading toward manned space flight, it could be of no great consequence. Hence NASA's pedestrian, almost condescending attitude.

Notwithstanding such difficulties, the program continued its pace toward a May launch. Everything grew frantic. The lapse between rejection of the ground equipment for the New Hampshire readout station on the grounds of poor workmanship and the acceptance of rebuilt equipment was eight days; the basic vehicle, the payload, and the individual motors arrived at Vandenberg within six days of one another, with the checkout van arriving but six weeks before the actual first launch.

On 25 April the first West Coast Scout launching was attempted. It seemed a bad omen. Unhappily, the third stage functioned most improperly, to the end that the two upper stages together drove into the Pacific Ocean.[15]

Disappointed but not discouraged, the program people turned back to their work on the first vehicle--the second West Coast Scout. By 1 May the initial Program 35 Scout had been mated with the first "operational" payload on the pad at Vandenberg. There was a dress rehearsal on 7 May and a launch attempt on 13 May, scrubbed because of various technical problems. Ten days later, after minor holds, the first Program 35 vehicle lifted off the launch pad. A catastrophic failure during second-stage burn ended the test.[16]

The post-launch investigating committee decided that improper assembly of the basic vehicle was the most probable source of failure, although that was never finally established. The launch officer at Vandenberg suggested that transporting the assembled Scout to the pad over a needlessly rough road might have caused enough misalignment of the stages to cause the trouble. General Greer was sufficiently concerned at the possibility to ask the Pacific Missile Range commander to fix the road, but he did not completely accept the thesis.

The first and second stages of the Scout vehicle were coupled by a shallow, threaded inner sleeve, six threads deep. After being rotated into place, it was held there by a three-quarter-inch pin driven through most of the vehicle skin and into the threaded sleeve. Pad workmen drilled the hole for the pin as part of the assembly process, and installed the pin once the vehicle was properly assembled. It all seemed simple and rather straightforward.

Unfortunately, NASA had no prime contractor for the Scout. At the time, the Scout was delivered to Vandenberg in 17 boxes from nine sources. Procedures were NASA's responsibility; neither the

Air Force nor the airframe contractor had authority to make changes--or responsibility for seeing that they were made when needed. Along the line, NASA engineers decided it was advisable to thicken the skin of the Stage I vehicle at the point where the threaded sleeve was to be inserted. Owing to the absence of a central configuration control authority, nobody examined the effect of the change on the assembly process. In putting the vehicle together, therefore, pad personnel rotated the sleeve as usual, drilled the required hole, and inserted the customary three-quarter-inch pin.

But this time the pin extended into an inch of skin, never touching the threads. No positive means of preventing sleeve rotation existed. Indeed, in some respects, it seemed almost as though Chance-Vought and NASA had combined forces to insure that the stages could not remain properly interconnected. Instead of the clean and dry threads required by specifications, the Scout used at Vandenberg had a fairly heavy coat of grease on the critical threads. The lubricant was perhaps needed to get a proper fit in the first place, but it contributed little to continued tightness. Then the metal grit left behind by the drill would also settle in the threads and under vibration might well serve as a sort of free rachet, permitting the sleeve to unscrew but acting like an irreversible cog to prevent tightening.

Subsequent efforts by the program office to get either Chance-Vought or NASA to test vibration effects in a realistic environment had no success, so program officers were never to be sure that they had located the chief source of difficulty. Except for the program office, nobody seemed to be particularly concerned. Even the fact of NASA's unilateral action in changing specifications did nothing to alter the situation.

There were other indications that the relationship between NASA and the Air Force was growing strained. One of the chief factors was the spare parts problem. For more than five months NASA had been ineffectually negotiating a spares contract with Chance-Vought, uniformly rejecting the contractor's proposals on the grounds of unwarranted cost or insufficient detail. Air Force people on the scene, though unable to take a hand, were convinced that NASA was almost entirely wrong on both counts. In any event, with no spare parts, and with no prospect of their early availability, the Air Force reverted to the eventual device of all supply sergeants, whether for chariots, muskets, B-24's, or solid-fuel missiles. Cannibalization began--and continued. And irritation with NASA increased.

Friction arose from other causes too. Launch crews were convinced that NASA's quite legal exercise of the right to override "hold" commands during Scout launches from the Pacific Missile Range had actually caused the first Scout failure there, in April. The "no go" item that NASA overruled seemed, by some evidence, the point of failure. That circumstance did little to endear NASA people to the Air Force. The launch officer at Vandenberg, however, was more than willing to take help where he could get it and was convinced that NASA had made highly useful contributions to the program. He, and a fair number at both SSD and SAFSP headquarters, felt that weaknesses in the Scout (Blue Scout) Program Office were more directly to blame both for the immediate launch problems and for the long-term difficulties.[17]

Needless to say, that was not the outlook of the Scout program director, who had much earlier concluded that "NASA Indians" resented the special priority of the Program 35 vehicles and supported that program only because such support was mandatory.[18]

Whatever the validity of the several positions, the issue of Scout responsibility was settled on 21 June 1962 by means of formal agreements between NASA and the Air Force. They conceded control of virtually all Scout matters to NASA, including general configuration, modification, launch stand procedures, and most related topics.[19] There was no prior coordination with the Program 35 people--who were concurrently acquiring a 698BH program designator. For the moment, neither the agreements nor the nomenclature change had any detectable effect. Attention was generally concentrated on the effort to get the next scheduled launch vehicle on its stand and ready.[20]

Through June and July 1962, a succession of modifications, revisions, and overhaul operations were performed with the next launch vehicle as the subject. (Vehicle 117 was to be used in lieu of 113, which had been mishandled in transport.) August 7th had been the original launch goal; optimism caused a shift to 28 July, which then slipped successively to 29 July, 30 July, 3 August, and 10 August (to permit payload modifications directed by Charyk). Modifications complete, the vehicle was rescheduled for a 13 August launch. At the critical instant, a Union Pacific passenger train crawled out on the track that crossed Vandenberg and for the first time in history a launching was scrubbed because of train interference.

On the following day, 14 August, monitors caught signs of excessive gyro drift during countdown and rescheduled for the 16th. Technical difficulties (problems with the C-section and the hydrogen peroxide subsystem) slipped that date to 18 August, and then 21 August when the Pacific Missile Range was unable to provide tracking services on the 18th. It seemed to many that the vehicle, and perhaps the entire program, was jinxed. One last slip carried launch over until 23 August, the eleventh official deadline date to be set that month. But on

23 August the Scout finally climbed away from its pad, all stages burned more or less as programmed, and the payload went into a near-optimum orbit. Direct readout was successfully attempted over the New Hampshire station on 26 August and on the following day the first remote readout data on cloud cover over the Soviet Union was taken from the same point in orbit.[21]

Nowhere in the official reports was there the indication that a great deal of luck had settled on the Scout a few seconds before launch, as if in restitution for the six weeks of misadventure that had gone before. Nor was that fact entirely clear following pre-launch. Often a period of several days passed before detailed information on booster performance became available, and when a bird went into a near-optimum orbit there seemed little enough reason to quibble over oddities in the launch process. In Colonel Haig's view, if Scout boosted the payload into any sort of orbit it was a near miracle; to get it into a near-optimum orbit was incredible.

Haig was quite right. There had been several peculiarities or errors of one sort or another during the launch, but none had individually done enough damage to cause complete failure. Had two combined, catastrophe would have resulted. Instead, in an unbelievable chain of coincidence, one fault cancelled out another.

At first-stage ignition the lanyards pulled out late, so all timers experienced a delayed start. The first-stage motors should, therefore, have burned out before the timers could signal second-stage ignition to begin. Instead, the first-stage motor inexplicably burned longer than it should have and first-stage thrust was near perfect for the mission.

Third-stage ignition was also late, by 0.54 seconds. Fourth-stage burning began, therefore, when the upper stage was further along its rough orbital trajectory than had been planned. But an earlier attitude error had caused a pitch down, and the effect of delayed fourth-stage ignition was to postpone the insertion process until the vehicle had drifted far enough along its orbital path to be in perfect position for fourth-stage burn.

The fourth stage was pointed some 0.4 degrees left of its predicted course at the time of spin-up. Spin-up invariably threw the vehicle a bit off course in an unpredictable direction, a phenomenon called tip-off error. In this instance, spin-up provided precisely the azimuth correction needed to insure a proper course. The final error was less than 0.1 degrees, which meant that the vehicle had gone into orbit close enough to true sun synchronization so that total drift over the next six months would total only 15-20 minutes (in sun time). (The next successful Program 35 bird drifted three sun-time hours in six months as a result of a 0.6 degree error.)[22]

Colonel Haig called Colonel R. A. Berg, Greer's deputy, from Vandenberg the afternoon the details of the launch were first put together. He asked Berg to stay a few minutes past usual closing time to hear something Haig had to tell him. The C-47 shuttle from Vandenberg landed about two hours later, and at dusk Colonel Haig was verbally piecing together the tale of coincidence and happenstance which had resulted in so fine an orbit. Berg was fascinated. General Greer's reaction was similar. In a business where the unique was commonplace, Haig's tale kept a place of honor. In any comparisons of satellite program oddities, citation of the event was almost certain.

Even though the outcome had been happy, there was little to cheer in total booster performance once the truth was known. Nor, in the circumstances, did relations with NASA improve over the period of the first two launches. NASA contended, apparently quite serious, that the launch attempt of 23 May had failed because of the MG-18 upper stage (although it was a tortuous trail between the real culprit, the second stage, and the MG-18, which had never been given time to begin separation from the third stage). NASA pointed out, correctly, that the MG-18 had never been flight tested, and that it was not "qualified" in the sense of having completed a demanding flight trial program--but even at that the MG-18 had certain obvious attractions as compared to advantages of NASA's proposed upper stage and its record of complete failure. There was a certain rude humor to the news that NASA had urged the commander of the Pacific Missile Range to close his facilities to the MG-18 because that stage was "not qualified." And the final scene, the 23 August launch, became almost ludicrous when NASA officials refused to let their people go near the final stage--in effect the entire launch site--claiming that the launch was a dangerous operation.

In the light of such events, Haig and his people could generate little enthusiasm for a proposed joint operation, a project office structure which would put NASA into a sort of Siamese twin relationship with Haig's people by means of a NASA link to the Scout program office. The prospect of such an arrangement had begun to alarm Colonel Evans in May; his initial inquiry into Colonel Haig's reaction to a proposed NASA-USAF agreement on Scout prompted several critical comments. As Haig later explained, he felt that a joint project office, in the unhappy tradition of past Air Materiel Command-Air Research and Development Command joint offices, would be responsible either to no master or to two, that each half would have a veto power but no approval authority. Candidly, Haig estimated that Program 35 would never have progressed to first launch attempt by that time if a joint office had existed. NASA, he reminded one listener, had strenuously opposed a great many Program 35 decisions which later proved perfectly valid and which in any event offered the only chance of staying on schedule and getting critical equipment. He did not say MG-18, or "upper stage," but his meaning was clear. It was Colonel Haig's conviction that the inability of the Air Force Scout program office to provide entirely satisfactory service was the product of faulty second-echelon management. And in so many words, Haig said the Air Force Scout office was providing insufficient support to his project largely because its chief, Colonel Stine, was forced to do most of the work himself.[23]

Although Colonel Haig's appraisal of the problem apparently was blunt enough to quash notions of a joint project office, it could not prevent a modification of the original arrangement for booster procurement. The Air Staff was afraid that NASA might successfully invoke the Scout example to justify independent procurement of boosters developed by the Air Force: Thor and Atlas. It pained the Air Force to see a Thor given a new coat of paint, prominent NASA initials three feet high, and a name--Delta--which was supposed to indicate NASA origins. And unfortunately, that possibility had been overlooked until after the Air Force had designated its NASA-developed Scout boosters "Blue Scout."

In mid-October 1962, Dr. Charyk agreed that NASA would act as SAFSP's agent in contracting for additional Scout boosters. He specified that price and delivery dates had to be guaranteed and that product quality and program administration had to satisfy the requirements of Program 35. If these conditions were not acceptable, he told NASA, General Greer would contract for follow-on vehicles precisely as he had for the first four.[24]

In retrospect, that concession was to be recognized as a tactical error. Even though Charyk could not have known what NASA's future course would be, the small group which had placed the first Project 35 satellite in orbit had some pronounced--and readily available--opinions on the subject. They proved rather sound, on the whole.

For the moment, however, the matter seemed less vital than the burgeoning crisis in Cuban affairs and the possibility that persistent rumors of Soviet missiles in Cuba might have a foundation of truth. Reconnaissance of Cuba, chiefly by means of U-2 aircraft, began in September 1962. On the 12th of that month Charyk authorized the satellite controllers to activate "Haig's bird" over the Caribbean. The data thus obtained was read out during the next following pass over a friendly station. About 80 percent effectiveness was recorded in the remote readout operation.

Late in October, the United States thoroughly verified the presence of Soviet medium-range ballistic missiles in Cuba. While diplomatic tempers frayed, the United States intensified reconnaissance flights over Cuba and then instituted a blockade of that island. Weather information of the sort returned by the Program 35 satellite was demanded early in the period of preliminary reconnaissance and the requests multiplied as the crisis deepened.

Because of payload peculiarities, it was necessary to forego exposures over the Soviet heartland on orbits which had or would include exposures over the Caribbean. Power drain was too great and command circuitry was inappropriate for such operations. Direct readout took less power, and if adroitly conducted during the satellite's northward pass would leave time for controllers at New Boston to program the bird for an over-Russia series of exposures on the other leg of the orbit. During early October, therefore, the satellite frequently was turned on while passing over Cuba for direct readout from New Boston.

Early trials worked reasonably well. But as the Cuban affair became more tense and public awareness more general, long dormant military installations up and down the Atlantic Coast began to operate their radar devices virtually around the clock. As Haig later phrased it, "everything up and down the coast from DEW line to the University of Florida seemed to be on the air." Because of the curvature of the earth, the radar dish at New Boston had to be angled but six degrees from the horizontal to read out the satellite during its passage over Cuban waters. That low angle made the transmission particularly susceptible to interference--and the babel of radiation from regions south of Boston continued to grow louder.

A return to the remote readout process seemed inevitable. But there were new complications, quite apart from the fact that information on both Soviet and Caribbean cloud cover was increasingly needed as the tension mounted. It was the province of a military commander to decide which had the more urgent priority, if a choice had to be made. In case both were vitally needed, it would have been a military prerogative--and requirement--to bleed away all the power of the satellite, that being in the supreme national interest. But by the time something of the sort seemed inescapable, there were tentative indications that it might no longer be possible.

World geography being what it was, the satellite had to be commanded to take Caribbean pictures while moving northward in the vicinity of New Boston. The next pass, as it moved over the Caribbean on its way north again, was the final leg in one complete circuit of the earth. But in some instances exposures commanded from New Boston had not been made when the bird again overflew the Caribbean. Investigation indicated that as the satellite passed over the pole and began its southward run, down and across the Kamchatka Peninsula, signals from an alien source were causing it to rest command controls. The question of whether the interference was of a random nature or represented a successful Soviet ploy in counter-satellite technology remained unanswered for the moment. The requirement of a reliable means of direct readout became pressing, regardless of the reason.

In that environment, Colonel Haig called Colonel Jesse Lowe, a member of Undersecretary Charyk's Washington staff, to ask for a chance to propose a new approach. Haig told Lowe only that he thought he might have answers to both Kamchatka and Atlantic Coast interference problems. Lowe, who had been bedeviled for solutions for the previous two days, scheduled Haig for a meeting with Charyk. The next afternoon, 23 October, Haig appeared in Charyk's office with a hastily prepared presentation previously exposed only to General Greer. What he proposed was to set up a direct readout station at Eglin Air Force Base, Florida. In one stroke, such a station would eliminate reliance on remote readout commands that might be countermanded and would overstep obstacles to direct readout from New Boston. The equipment was available, Haig explained. The launch checkout van on the West Coast, which could be airlifted to Eglin, would provide all the needed command and readout capacity, while there happened to be on site at Eglin's Auxiliary Field Number 5 a TLM-18 antenna which would beautifully serve the direct readout needs of the Program 35 satellite. (Haig's certitude on the matter of the TLM-18 was well founded; a year earlier, while in the business of setting up command and control stations for another program, he had occasion to purloin a similar unit for emergency placement in an African site. He was quite familiar with the instrument's characteristics.) As it happened, Colonel Haig had earlier taken informal steps to insure that the TLM-18 would be ready if needed; he had phoned Eglin and without saying anything to identify objectives had told officers overseeing trials of the TLM-18 that it might be best to speed up acceptance tests, which were scheduled to take another three weeks, since the antenna might be requisitioned and Eglin might never have a chance to complete the tests later. The Eglin people took Haig's word and accelerated their activity. Haig had also assured himself that the equipment at Vandenberg could be airlifted.

Charyk approved Haig's proposal on the spot. On his way through Charyk's anteroom, Haig telephoned Eglin and Vandenberg.

He then climbed aboard the first airplane heading south. He was on Eglin's Auxiliary Field Number 5 the next morning. A quick conference with the senior officer on the spot (Brigadier General A. T. Culbertson), and a phone call to the program office confirmed actual departure. He spent the balance of the day writing station security and operating procedures.

The Vandenberg equipment arrived in Florida on 25 October; two days later, on Saturday, 27 October 1962, it was put in operation for the first time. (The new station was called Site IV--Leda Site.)

The first attempt at direct readout was only moderately successful, certainly not of the quality the Program 35 people had anticipated. They quickly located the trouble: electrical noise originating in the brushes of the auxiliary generator that provided power. A switch to commercial power drawn through Eglin was completed the following morning, and that afternoon, Sunday (28 October), the readout operators got extremely good results.

On the next day, attempts to read out through the bird's television eyes were completely unsuccessful. Power fluctuation and massive radiation interference frustrated every effort. The operators located the source of the radiation almost at once; in order to interrogate the satellite, the dish had to be aimed almost directly across the main housing area of Eglin Air Force Base, and lowering the scan angle slightly showed that huge quantities of radiation were streaming upward from that area into the path of the readout signals. The previous day's results had been so impressive because Sunday had been a lovely day and many of the inhabitants of the housing area had been absent. Monday was washday, which meant the continued use of electrical gadgets ranging from washers and dryers to television sets and vacuum cleaners. The combination readily explained why power fluctuated, and where the radiation originated.

Colonel Haig was in contact with General Culbertson's office scarcely minutes after the trouble had been identified. Culbertson, a genial, blunt officer who had recently left Wright Field after two frustrating years of exposure to the slow and contorted decision processes there, had come to favor a draconian approach to problems. Time being rather short, he informed as many Eglin residents as possible of his intentions and of his need for complete use of all local power--and then threw the main switch to the housing area. In that one stroke he solved the problem of current fluctuation and eliminated random electrical noise. Later that week, when matters had become less hectic, he inserted appropriate notices in the Eglin bulletin, advising readers that there would be periodic power outages. When he heard that automobiles driving under the cone of TLM-18 radiation might produce interference through their ignition systems, he called out the local Air Police, set up road blocks, and stopped every car within range of the dish.

Signal clarity was exceptional. So was the considerable degree of respect that Culbertson and Haig acquired for one another.[25]

As usual, loose ends remained. For one, the van flown to Eglin represented one-third of the applicable readout potential in the world and, at the moment, all of the launch check-out capacity available to Program 35. There was no crisis comparable to the Cuban imbroglio, but it was a dangling end and Haig's people set out to trim it off. With help from RCA's engineers, they cannibalized the factory check-out equipment, assembled a new readout complex, installed it at Site IV, and switched operation to the new equipment. On 11 November the original van was flown back to Vandenberg. One day later, the manufacture of new equipment for factory check-out sets began.

Virtually nobody outside the original circle of cognizant Program 35 people knew of the Eglin operation. (General Culbertson was never fully briefed, for instance.) In terms of the hundreds of thousands of uniformed personnel who were alerted or shifted about late in October 1962, the Program 35 operation seemed insignificant. Yet General Power later said it had been worth as much as three wings of B-52's, and from a bomber man that was a significant compliment, even if there was a possibility that it also reflected satisfaction over a parallel decision to give operational responsibility for the Program 35 satellites to the Strategic Air Command. In any event, the establishment and activation of a direct readout station in the Caribbean had taken an unbelievably brief time, had been successfully conducted in an atmosphere of extraordinary security, and had required relatively few people. Moreover, those people--from Charyk through the least senior of the antenna operators--had consistently functioned with a directness that seemed quaintly archaic in its vigor and enthusiasm. The episode was a thoroughly refreshing interlude in an otherwise stodgy fright contest between nuclear behemoths.

In retrospect it was clear that the separation of Program 35 from the ponderous main trunk of research and development had much to do with the success of the Eglin operation. Colonel Haig, who had a Parkinsonian distaste for officiousness, arranged for transportation and installation of the equipment by placidly ignoring ordained channels. General Culbertson obviously relished his opportunity to take direct, effective action. So did most of the junior officers and the RCA technicians who were indispensable to the operation. It was clear that personal enterprise had as much to do with the success of the undertaking as did technical skill.[26]

In parallel with the decision to set up an Eglin readout station, Charyk had confirmed a set of rulings which put Program 35 on a new course. On the day following Colonel Haig's proposal of the Eglin solution, Charyk notified General Greer of his approval, not only of the Eglin proposal, but also of suggestions that the Strategic Air Command be offered the job of operating the Program 35 satellites under the direction of the program office, and that provisions be made for standby launches to provide additional cloud cover satellites as needed.[27] In one stroke, the program office had become responsible for creating and manning (with SAC people) two semi-permanent readout stations and for an extended program. That expansion of the mission had its own migraine potential, while there remained the eternally more difficult problem of dealing successfully with NASA in matters concerning the booster. The satellite itself had proved almost trouble free; unhappily, there could be few demonstrations of its potential while its booster remained unreliable to a degree that the Air Force could not accept.

There were some special problems in operating a military satellite over a long period of time. Oddly enough, they had not been accurately foreseen in some five years of planning for the day when